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FINAL SUMMARY REPORT

OPTIMIZATION AND EVALUATION OF ELECTROPHORETIC PROTECTIVE COATINGS FOR TANTALUM T-222 ALLOY

Ву

S. J. Klach and M. H. Ortner

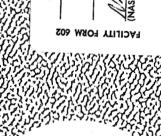
December, 1967

Prepared for
National Aeronautics and Space Administration

Contract NAS 3-9405

R. E. Oldrieve - Project ManagerS. J. Grisaffe - Research Advisor

NASA Lewis Research Center Cleveland, Ohio 44135





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## OPTIMIZATION AND EVALUATION OF ELECTROPHORETIC PROTECTIVE COATINGS FOR TANTALUM T-222 ALLOY

## **ABSTRACT**

Coating process parameters including composition, siliconization time, pre-oxidation time and temperature, and double versus single layer coatings were evaluated during this program in order to improve the oxidation resistance and coating reliability of a variety of silicide coating systems. The coatings were evaluated in terms of oxidation life at 1500°F and 2400°F under cyclic conditions.

The most promising systems developed under this program consisted of either MoSi<sub>2</sub>-20TiSi<sub>2</sub> or MoSi<sub>2</sub>-40CrSi<sub>2</sub> coatings deposited over a VSi<sub>2</sub> barrier layer. These coating systems, at an overall thickness of approximately 2.5 mils, showed the capability of surviving 600 hours exposure at 1500°F and 2400°F under cyclic conditions. In extended testing at 1500°F and 2400°F, the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> coating system yielded oxidation lives of 1398 hours and 824 hours, respectively. The specimen of the 1398 hour test was still intact after terminating the test program. Ductility after test was lacking, however.

Excellent coating reproducibility was exhibited by the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating system. Eight of the ten specimens tested (4 at each temperature of 1520°F and 2400°F) survived 626 hours of cyclic testing. The excellent performance of these systems is attributed to the oxidation resistance and self-healing capability of the VSi<sub>2</sub> underlayer.

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#### 1. INTRODUCTION

This is the Final Summary Report on Contract NAS 3-9405, covering the period 1 July 1966 through 27 October 1967. This report has been assigned NASA No. CR 72358. The Project Manager and Research Advisor for this program were R. E. Oldrieve and S. J. Grisaffe, respectively, of the NASA Lewis Research Center. Personnel at Vitro contributing to the performance of this program included:

M. H. Ortner - Program Manager
S. J. Klach - Project Leader
L. Evans, W. Lee, J. Morlino - Research Technicians

The ultimate objective of this program was to develop and evaluate coated materials which can operate for 3000 hours as turbine stator vanes in advanced jet engines. The immediate objective of the program under the current contract was the optimization of process parameters and the improvement in high temperature and low temperature reliability of electrophoretically deposited refractory silicide coatings for tantalum base alloys.

In a previous contract (NAS 3-7613) highly modified silicide-base coatings were developed which showed promise for protecting tantalum alloy from oxidation at 1500°F and 2400°F. The reliability of the systems developed, however, was marginal and efforts under this contract were therefore concentrated in optimizing process parameters and improving the reliability of these silicide coating systems. Originally, the program was designed to be performed in three tasks, as follows:

Task I - Optimization of Coating Chemistry and Processing Conditions

Task II - Statistical Evaluation

Task III - Preparation of Twenty (20) Silicide Coated Wedge-Shaped Specimens for Delivery to the Project Manager.

Toward the end of the program Tasks II and III were deleted from the program in order to further investigate the subject matter of Task I. This report summarizes the Task I effort.

#### 2. SUMMARY

The immediate objectives of this program were to (a) optimize the MoSi<sub>2</sub>-base coating process parameters in order to provide 400 hours protection at 1500°F and 2400°F for tantalum base alloys, and (b) improve the high and low temperature reliability of these silicide coating systems.

Coating parameters such as coating composition, siliconization time, preoxidation time and temperature, coating density and double coating vs single
coating were evaluated initially. It was determined that coating composition
and siliconization time were the only variables which had a favorable effect
in improving the oxidation performance of the silicide coating systems investigated. Coating compositions of MoSi2-10VSi2, MoSi2-20TiSi2, and
MoSi2-30CrSi2, and a siliconization time of 8 hours at 2370°F under reduced
pressure were found to be optimum. The remaining variables (preoxidation
time and temperature, coating density and double coating) were found to be
ineffective in improving the life or the reliability of the three single-layer
binary silicide systems.

Although some improvement in life was noted after optimizing the siliconization time of the three single-layer binary silicide systems, the program goal of 400 hours cyclic life at 1500°F and 2400°F was not achieved. In subsequent experiments, however, the use of a vanadium silicide barrier layer on T-222 alloy, overcoated with either the binary MoSi2-20TiSi2 or MoSi2-40CrSi2 systems to a total thickness of approximately 2.5 mil, was found to give excellent protection at both test temperatures. This coating system concept was considered a breakthrough for achieving the desired oxidation life of 400 hours at 1500°F and 2400°F and for improving the reliability of the silicide coating systems.

At 1500°F, oxidation lives of 400 and 1398 hours were realized without failure with the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> and MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> coating systems, respectively. At 2400°F, 400 and 824 cyclic oxidation hours at temperature were obtained for the respective coating systems. Specimens were cooled in air to room temperature between each cycle.

In subsequent reliability tests conducted at 1500°F and 2400°F, the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating system exhibited very good coating reproducibility. Of ten (10) T-222 specimens tested (5 at each test temperature), nine specimens survived 400 hours of cyclic testing. Four (4) at each test temperature or a total of eight (8) specimens survived 626 hours of cyclic testing without failure.

Reliability tests conducted on the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> coating system (40 specimens) showed poor coating reliability which was in conflict with previously obtained results. Most of the specimens tested (26) failed in less than 30 hours of testing at 1500°F and 2400°F.

Although time did not permit an investigation of the cause of the early failure of the VSi2-MoSi2-20TiSi2 reliability specimens, a later check of the experimental data revealed that a new batch of prealloyed powder had been used for this group of specimens, and that the 40 reliability specimens had been inadvertently silicided for 8 hours (Appendix A pages 59 to 66) instead of 16 hours. The longer siliconization time was used in earlier oxidation tests (Appendix A pages 55 to 66) of the same system which resulted in a minimum of 800 hours of cyclic oxidation life at 1500°F and at 2400°F in extended testing.

Bend tests (4t) conducted on MoSi2-20TiSi2/VSi2 and MoSi2-40CrSi2/VSi2 coated T-222 specimens after oxidation testing for 400 hours at 2400°F showed a loss of ductility of the T-222 alloy substrate indicating oxygen contamination during testing. All specimens tested broke at a bend angle of ten degrees or less. The "ductile life" of the coating systems was not determined.

Electron microprobe analysis of the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub>, MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub>, and 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> coating systems showed silicon to be the predominant specie diffusing into the T-222 substrate before and after oxidation testing.

Tantalum diffused, to some degree, into all of the coating systems as a result of the sintering treatment. After oxidation testing, tantalum was found to diffuse completely through the MoSi2-40CrSi2/VSi2 coating while being inhibited in the MoSi2-20TiSi2/VSi2 coating system.

#### 3. EXPERIMENTAL

#### 3.1 Materials and Equipment

#### 3.1.1 Substrate Material

The 2 in. x 1 in. x 0.060 in. test specimens used in this program were sheared from T-222 alloy sheet supplied by Wah Chang Corporation. Analyses, identification, and properties of the two lots of tantalum alloy sheet used are listed in Tables 1 and 2. The T-222 alloy sheet of Heat No. 65041 was material that remained from a previous program (Contract NAS 3-7613) and this material was used for preparing specimens for the siliconization study (Section 3.2.3). All other specimens were prepared initially from the T-222 sheet of Heat No. 65070 (Table 2). However, due to a shortage of substrate material toward the end of the program, it was necessary to reclaim specimens from both tantalum lots. The specimens that were reclaimed were those that were rejected before oxidation testing because of coating defects. Reclamation of the defective silicide coated T-222 specimens was achieved by a sandblasting treatment using 60 grit alumina. Removal of the surface silicide coating and the diffusion zone layer by this technique was complete when the surface of the specimen changed from a bright metallic appearance (diffusion zone) to a dull finish (unaffected substrate). Complete removal of the coating by grit blasting was confirmed by metallography.

#### 3.1.2 Coating Material

The silicide powders investigated as candidate coating systems were purchased from Cerac, Inc. with the following specifications:

#### Specifications for Coating Materials

Material		Specifications	
WSi <sub>2</sub>	Minimum Purity	99.5%, -325 mesh powder	
MoSi <sub>2</sub>	Minimum Purity	99.5%, -325 mesh powder	
TiSi2	Minimum Purity	98.8%, -325 mesh powder	
$VSi_2$	Minimum Purity	99.5%, -325 mesh powder	
CrSi <sub>2</sub>	Minimum Purity	99.5%, $-325$ mesh powder	

The spectrographic analyses of these materials are listed in Table 3. These analyses were furnished by the vendor.

TABLE 1 TANTALUM ALLOY T-222 INGOT ANALYSIS HEAT NO. 65070-T-222

1 2 3 4 Hf 2.7 2.7 2.7 2.4 W 10.3 10.5 10.0 10.4	
W 10 3 10 5 10 0 10 4	
W 10.3 10.5 10.0 10.4	
Ingot Impurities in PPM	
Al < 10 < 10 < 10 < 10	
B <1 <1 <1 <1	
C 100 100 120 100	
Съ 800 660 780 900	
Co <5 <5 <5 <5	
Cr <10 <10 <10 <10	
Cu < 20 < 20 < 20 < 20	
Fe 35 35 35	
H 2.2 2.4	
Mo 30 30 40	
N 35 50 40 45	
Ni < 10 < 10 < 10 < 10	
O < 50 60	
Si < 20 < 20 < 20 < 20	
Ti < 20 < 20 < 20 < 20	
V < 10 < 10 < 10 < 10	

Ingot Hardness	in	BHN		
Average	,		262	
Range		255	-269	

Final Anneal 1 hr. @ 3000°F Vacuum of  $1 \times 10^{-4}$ Torr

	Product Ch	emistry in PPM
	C	110
	0	120
	Ň	10
	H	3.3
	Product l	Hardness, DPH
	Edge	258
	Center	288
	Edge	278
	Metalloo	graphy Report
		% recrystallized
101	ateriar is 100	7,0 Teerystallized
	ASTM	Grain Size
	Sample	
	11 1	÷ Ε

ASTM	Grain Size
Sample	
#1	7.5
#2	-8

Tensile	Test Resu	lts @ Room Ter	np. Trans.
	Tensile	Yield Strength	Elongation
Sample	Strength	(0.2% Offset)	% in 1"
#1	121.0 ksi	104.0 ksi	27.0
#2	121.0 ksi	105.0 ksi	26.0

## Bend Test Results @ Room Temp. 105° 1T

2 Trans. Acceptable Specimens bent without cracking.

## Processing History

- 1. Forge 7" dia. to 1-1/2" x W x L
- 2. Anneal
- 3. Warm Roll 1-1/2" to .250" x W x L
- 4. Anneal
- 5. Cold Roll .250" to .062"  $\times$  W  $\times$  L
- 6. Final Anneal

TABLE 2
TANTALUM ALLOY T-222 INGOT ANALYSIS
Heat No. 65041-T222

#### INGOT ANALYSIS

	COMPOSIT	ION IN	PERCENT	
Hf	2.9	2.7	2.7	2.4
W	8.8	8.6	9.0	9.4
Та	88.3	88.7	88.3	88.2
	IMPURITY	CONT	ENT, PPM	
Al	<20	<20	<20	<20
C	110	90	110	120
СЪ	525	600	590	445
Cd	<5	<5	<b>&lt;</b> 5	<5
Co	<10	<10	<10	<10
Cr	<20	<20	<20	<20
Cu	<40	<40	<40	<40
Fe	<40	<40	<40	40
Mg	<20	<20	<20	<20
Mn	<20	<20	<20	<20
Mo	30	40	30	30
N	20	20	25	20
Ni	<20	<20	<20	<2.0
Pb	<20	<20	<20	<20
Si	<40	<40	<40	<40
Sn	<20	<20	<20	<20
Τi	<50	<50	<50	<50
V	<20	<20	<20	<20
H	3.1			3.2
0	<50			<50

HARDNE			
Average			254
Range	24	48	- 262

PRODUCT	CHEMISTRY, PPM
С	180
.0	50
N	8
H	2 -

TENSILE	TEST RESULTS	S AT ROOM TEMPE	CRATURE
Sample	Tensile Strength	Yield Strength (0.2% Offset)	Elongation % in 2"
Long. #1 Long. #2 Trans. #1 Trans. #2	114,000 psi 114,000 psi 117,000 psi 118,000 psi	102,000 psi 101,000 psi 103,000 psi 106,000 psi	22.5 22.5 22.5 21.5

ASTM	GRAIN	SIZE
	7.5	

PRODUC	T HARDNES	S, DPH
Sample	Center	Edge
#1	301	302
#2	309	317

#### BEND TEST RESULTS AT ROOM TEMPERATURE

Trans. - Acceptable - Samples Bent Long. - Without Cracking

TABLE 3
SPECTROGRAPHIC ANALYSIS OF
SILICIDE COATING MATERIALS
(Data furnished by Cerac, Inc.)

	$\frac{\text{CrSi}_2}{}$	TiSi <sub>2</sub>	VSi <sub>2</sub>	WSi <sub>2</sub>	MoSi <sub>2</sub>
Mn	0.01-0.1	0.01-0.1	0.005-0.05	0,001-0.01	0.001-0.01
Ni	0.05-0.5	none	0.01	0.01	0.001-0.01
Cr		none	none	0.05-0.5	0.01-0.1
Мо	0.01-0.1	none	0.1-1.0	0.01	
Cu	0.01	0.01	0.01	0.01	0.01-0.1
v	0.01	none		none	0.001-0.01
Fe	0.1-1.0	0.1-1.0	0.1-1.0	0.1-1.0	0.01-0.1
Al	0.01	0.01	0.01	0.01	0.001-0.01
Mg	0.001	0.001	0.001	0.001	none
Ti	0.01-0.1		0.01-0.1	0.001	0.001-0.01

These raw materials, prior to dispersion preparation, were weighed, mechanically blended in the selected coating composition, and milled for 24 hours in a chromium steel ball mill using isopropanol as the milling medium. The milled powders were leached with dilute hydrochloric acid, washed with distilled water, and dried. The powders were then pelletized, isostatically pressed at 30 tsi and prealloyed at 2910°F for 72 hours under argon. The 72 hour prealloying time was used on the basis of results obtained in the pellet studies described in Section 3.2.1. The prealloyed pellets of each silicide composition were finally crushed to -100 mesh powders and milled again for 24 hours, leached with acid, washed and dried. The resulting (approximately 10 micron) powders were then used to prepare the various electrophoretic dispersions.

### 3.1.3 Coating and Testing Equipment

The electrophoretic coating equipment used in this program consisted of a stainless steel tank (one pint capacity), a recirculating centrifugal pump, a Hewlett Packard DC power supply (0-500 volt range) and a timer. A schematic drawing of this apparatus is shown in Figure 1.

Sintering and oxidation testing at 2400°F of the electrophoretically applied coating were done in a multi-tube Globar-heated furnace. The temperature of the Globar furnace was indicated by a Pt-6 Rh/Pt-30 Rh thermocouple, and the accuracy of the furnace thermocouple was checked against a standard thermocouple of the same type.

Oxidation tests at the 1500°F test temperature were conducted in a Hevi Duty, 5 inch diameter Hinged Combustion Tube Furnace. The temperature was controlled by a Wheelco Capacitrol Model 292 and indicated by a Pt/Pt-13 Rh thermocouple. Stress relieving the T-222 specimens prior to coating was accomplished in a Brew Vacuum Furnace, Model 1064.

#### 3.2 Coating Development

### 3.2.1 Selection of Coating Systems

A total of eighteen binary MoSi<sub>2</sub> and WSi<sub>2</sub>-base coating systems containing 10%, 20%, and 30% additions of CrSi<sub>2</sub>, TiSi<sub>2</sub> and VSi<sub>2</sub> were initially selected and screened as potential coating systems for protecting tantalum base alloys from oxidation at 1500°F and 2400°F. These systems were chosen on the basis of results obtained in previous work under Contract NAS 3-7613<sup>(1)</sup>.

<sup>(1)</sup> See References following body of report.

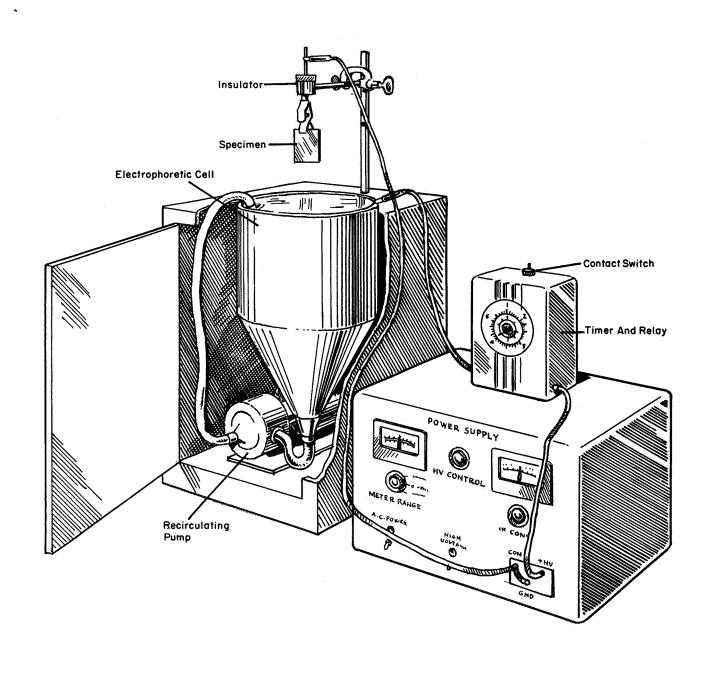


FIGURE 1
ELECTROPHORETIC COATING APPARATUS

The screening of the selected MoSi<sub>2</sub> and WSi<sub>2</sub>-base coating systems was begun by oxidation testing at 1500°F prealloyed pellets of the various silicide combinations to determine their susceptibility to "pest" formation. Prior to testing, however, a preliminary evaluation was made of the use of X-ray diffraction as an analytical tool to determine the extent of solid solubility of the binary silicide coating system as a function of the time and temperature of heat treatment. The X-ray diffraction studies were done by E. F. Fullam, Inc., and the following silicide pellet specimens were examined:

Specimen No.	Description		
WO-410-94-1	WSi <sub>2</sub> -30VSi <sub>2</sub> pellet, densified at 40 tsi, fired in argon at 2730°F for 72 hours		
WO-410-94-2	WSi <sub>2</sub> -30VSi <sub>2</sub> pellet, densified at 40 tsi, fired in argon at 2730°F for 24 hours		
WO-410-94-3	WSi <sub>2</sub> pellet, densified at 50 tsi		
WO-410-94-4	VSi2 pellet, densified at 40 tsi		
WO-410-94-5	WSi2-30VSi2 fused fragment		

Each of the specimens was ground to -325 mesh powder and examined under identical conditions to allow direct comparison of the results. X-ray diffraction patterns were obtained using the diffractometer at 35 kv and 15 ma with nickel-filtered copper radiation. The original diffraction traces are shown in Figure 2. The following conclusions were drawn from this experiment:

- a) WSi<sub>2</sub> and VSi<sub>2</sub> produce distinctive diffraction patterns that can be readily differentiated.
- b) Diffraction peaks of both WSi2 and VSi2 were obtained from the three samples containing WSi2 with 30% VSi2. Therefore complete solid solubility was not obtained in any of the mixtures.
- c) The diffraction peaks for both the WSi2 and VSi2 were shifted slightly in the three samples of WSi2-30%VSi2 thereby indicating some solubility of V in WSi2 and some solubility of W in VSi2.
- d) No detectable amounts of phases other than the disilicides were present.

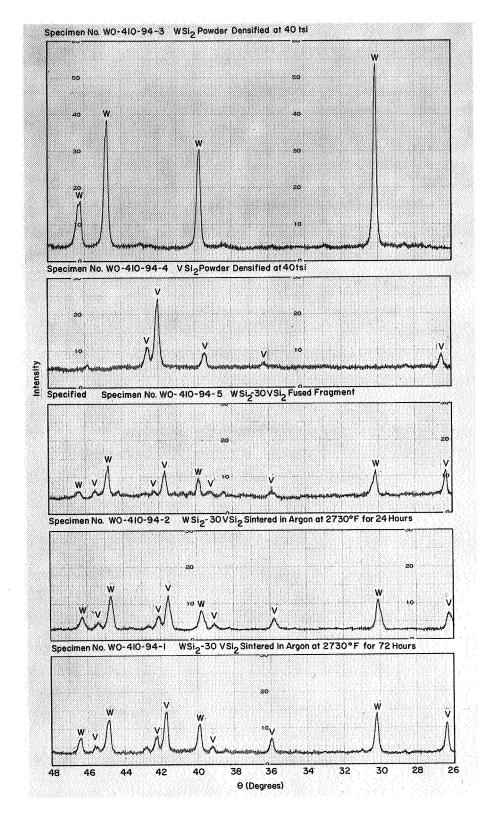


FIGURE 2

X-RAY DIFFRACTION TRACES OF WSi<sub>2</sub>, VSi<sub>2</sub>, AND WSi<sub>2</sub>-30VSi<sub>2</sub> POWDERS

- e) Comparison of the degree of line shift of the two samples sintered at 2730°F shows a greater line shift after the 24 hour treatment than after the 72 hour treatment. This observation indicates some unknown effect or transformation which is time dependent.
- f) The diffraction peaks of the 72 hour prealloyed sample and the fused fragment appear identical indicating that a 72 hour prealloying time at 2730°F is sufficient to attain the maximum degree of mutual solubility that can be achieved with the WSi2-VSi2 system.

At the onset of the X-ray evaluation of solid solubility it was anticipated that all binary silicide systems chosen for coating studies would be analyzed by this technique. However, due to the time consuming nature of this approach, it was decided to utilize the 72 hour prealloying schedule for all the silicide coating combinations earmarked for investigation under this program.

In the pellet oxidation tests at 1500°F for determination of susceptibility to "pest" formation, the following two groups of mixed silicides were prepared and tested:

Group I	Group II
WSi2-10%VSi2	MoSi2-10VSi2
$WSi_2-20\%VSi_2$	MoSi <sub>2</sub> -20VSi <sub>2</sub>
$WSi_2 - 30\% VSi_2$	MoSi2-30VSi2
WSi <sub>2</sub> -10%TiSi <sub>2</sub>	MoSi2-10TiSi2
$WSi_2-20\%TiSi_2$	MoSi2-20TiSi2
WSi2-30%TiSi2	MoSi2-30TiSi2
WSi <sub>2</sub> -10%CrSi <sub>2</sub>	MoSi2-10CrSi2
$WSi_2-20\%CrSi_2$	MoSi <sub>2</sub> -20CrSi <sub>2</sub>
WSi <sub>2</sub> -30%CrSi <sub>2</sub>	MoSi <sub>2</sub> -30CrSi <sub>2</sub>

The procedure for evaluating these systems was as follows:

- a) The silicide powders (-325 mesh), blended in the desired proportion, were milled for 24 hours in a chrome steel mill, leached with dilute acid, washed with distilled water and dried.
- b) The milled powders were pelletized at 30 tsi and prealloyed at 2730°F for 72 hours under argon. In the case of the WSi2-TiSi2 system the pellets shattered during the

prealloying cycle. According to G. V. Samsonov, et al (2) new phases having a hexagonal structure are formed with this type of alloy. Therefore, the shattering of the pellets probably resulted from the high stress development that accompanied the phase transformations. The shattered pellets were reworked (crushed, ballmilled, pelletized and prealloyed for 72 hours at 2730°F in argon) and oxidation tested at 1500°F for "pest" evaluation.

c) Three pellets of each silicide combination were fractured and oxidation tested at 1500°F to determine the extent of "pest" formation. The results are summarized in Table 4.

Of the silicide systems evaluated, none of the MoSi<sub>2</sub>-base binary systems showed pest formation after 600 hours of testing, whereas in the WSi<sub>2</sub>-base system, only the WSi<sub>2</sub>-30CrSi<sub>2</sub> did not form the "pest" after 600 hours of testing. All the other combinations containing WSi<sub>2</sub> exhibited some degree of pest formation after short exposure times (16 hours) at 1500°F. The pellets containing the higher additive concentration showed the least amount of pest formation while the pellets containing 10% and 20% TiSi<sub>2</sub> additions exhibited catastrophic "pest" attack. The oxidation test results for the WSi<sub>2</sub>-30VSi<sub>2</sub> pellets were in agreement with the results of the X-ray analysis of this system which indicated the presence of free WSi<sub>2</sub> after prealloying.

On the basis of these results only the MoSi<sub>2</sub>-base coating system was selected for further optimization and the WSi<sub>2</sub>-base coating systems were eliminated from the program. As the program progressed, however, it became apparent that optimization of the process parameters, although improving the oxidation performance of the various silicide coating systems to some degree, did not resolve the poor coating reliability problem associated with the binary, single-layer silicide coating systems.

In order to realize this program objective the following six silicide coating systems were also selected for evaluation:

- a) MoSi2-CrSi2/VSi2 (barrier layer)
- b) MoSi2-TiSi2/VSi2 (barrier layer)
- c) Siliconized Mo-15.4Ti
- d) MoSi2-15CrSi2-15VSi2
- e) CrSi2-20TiSi2
- f) MoSi2-WSi2-TiSi2-VSi2

RESULTS OF OXIDATION TESTS OF VARIOUS MIXED SILICIDE PELLETS AT 1500°F

TABLE 4

Silicide System	Exposure Time at 1500°F (hours)	Results
WSi2-10VSi2	2	Catastrophic pest formation
WSi2-20VSi2	2	Catastrophic pest formation
WSi2-30VSi2	2	Slight pest formation
$WSi_2 - 10VSi_2$	16	Catastrophic pest formation
$WSi_2-20VSi_2$	16	Catastrophic pest formation
WSi <sub>2</sub> -30VSi <sub>2</sub>	16	Slight pest formation
WSi <sub>2</sub> -10CrSi <sub>2</sub>	71 - 141 (over weekend)	Slight pest formation
WSi <sub>2</sub> -20CrSi <sub>2</sub>	71 - 141 (over weekend)	Slight pest formation
WSi2-30CrSi2	600	No indication of pest
MoSi <sub>2</sub> -10VSi <sub>2</sub>	600	No indication of pest
$MoSi_2-20VSi_2$	600	No indication of pest
$MoSi_2-30VSi_2$	600	No indication of pest
$MoSi_2 - 10TiSi_2$	600	No indication of pest
$MoSi_2-20TiSi_2$	600	No indication of pest
$MoSi_2-30TiSi_2$	600	No indication of pest
$MoSi_2-10CrSi_2$	600	No indication of pest
MoSi <sub>2</sub> -20CrSi <sub>2</sub>	600	No indication of pest
MoSi <sub>2</sub> -30CrSi <sub>2</sub>	600	No indication of pest

## 3.2.2. Coating Procedures

The coating material for each coating system was prepared according to procedures described in Section 3.1.2. The T-222 specimens (2 in x 1 in x 0.060 in) prior to coating, were tumbled for 24 hours in an alumina mill to radius the edges and corners, sandblasted with 60 grit alumina, washed, and vacuum annealed at 2550°F for 1 hour.

All coatings were electrophoretically applied from a typical dispersion containing 40 grams of solids dispersed in a medium of the following composition:

- 0.81 liters of 60 wt % isopropanol 40 wt % nitromethane
- l gram zein activator
- mgs  $Co(NO_3)_2 \cdot 6H_2O$

Considerable difficulty was experienced in stabilizing electrophoretic dispersions containing the binary silicide powders so as to yield a 5.0 mil thick as-deposited coating. A 5-mil as-deposited thickness was required in order to obtain a nominal 2.5 mil-thick sintered coating. A large number of specimens had to be rejected after the sintering operation as a result of shrinkage cracks which developed in the coating. In order to circumvent this problem, it was decided to aim for a coating thickness which would not be troublesome to obtain during the electrophoretic deposition step of the process, and which would also be capable of being sintered free of defects.

Exploratory studies directed toward this objective were very encouraging. The study indicated that a 3.0-3.5 mil thick as-deposited coating could be readily applied electrophoretically and sintered free of shrinkage cracks to a thickness of 1.5-1.7 mils. This modification reduced considerably the number of specimens which had to be rejected after sintering.

The processing conditions for all specimens of each coating system which was investigated are tabulated in Appendix A. It will be noted that in some instances the processing conditions were modified from the "standard" procedures in order to expedite the coating program. For example, in sintering the MoSi<sub>2</sub>-base coating systems, containing 30% additions of VSi<sub>2</sub> or TiSi<sub>2</sub>, the coatings, in a majority of cases, did not adhere to the T-222 substrate. It was observed that the coating, after cooling to room temperature, broke away or spalled from the substrate as shown in Figure 3. This phenomenon indicated the formation of a weak coating structure that could not contain the thermally induced stresses of the coating-substrate system. In order to strengthen the coating structure it was found necessary in this case to increase the sintering temperature from 2910°F to 3090°F. The

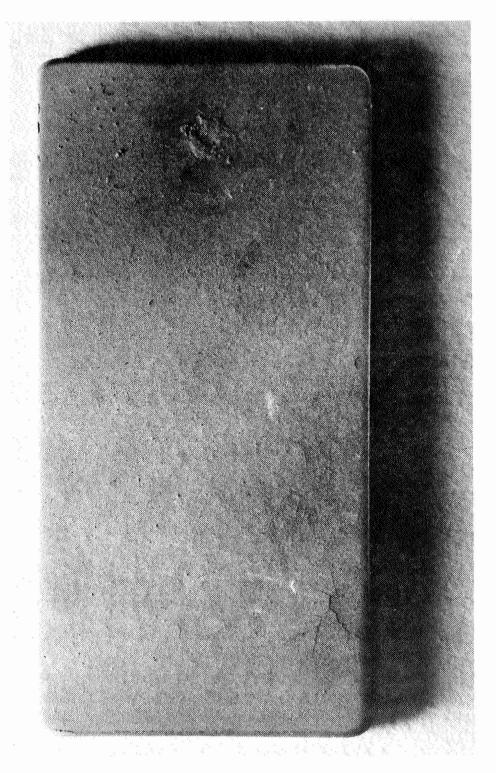


FIGURE 3 Magnification 3X

TYPICAL COATING FAILURE OF MoSig-30VSig ON T-222 AFTER SINTERING AT 2910° F FOR 2 HOURS UNDER ARGON

structural differences between the 2910°F and 3090°F sintered MoSi2-30VSi2 coatings are shown in the photomicrographs of Figure 4. The higher sintering temperature apparently served to partially eliminate the void between the coating and the diffusion zone.

### 3.2.3 Optimization of Process Parameters

The coating process parameters investigated during this program included:

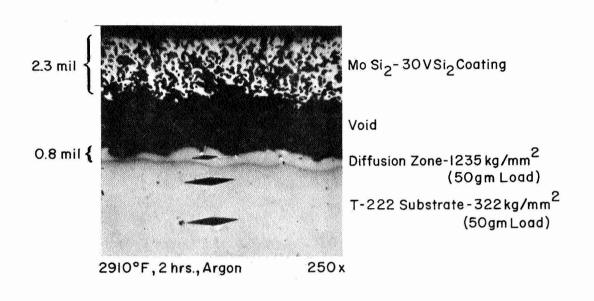
- a) Coating Composition
- b) Siliconization Times
- c) Preoxidation Time and Temperature
- d) Double Layer Coating Application.

### Coating Composition

The coating compositions evaluated in this study consisted of:

- a)  $MoSi_2$  coatings containing 10%, 20%, and 30% additions of  $CrSi_2$
- b) MoSi<sub>2</sub> coatings containing 10%, 20%, and 30% additions of TiSi<sub>2</sub>
- c) MoSi<sub>2</sub> coatings containing 10%, 20%, and 30% additions of  $VSi_2$
- d) Siliconized Mo-15.4Ti
- e) MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub>
- f) MoSi2-30CrSi2/VSi2 (barrier layer)
- g) MoSi2-40CrSi2/VSi2 (barrier layer)
- h) MoSi2-20TiSi2/VSi2 (barrier layer)
- i) 35MoSi<sub>2</sub>-35WSi<sub>2</sub>-15TiSi<sub>2</sub>-15VSi<sub>2</sub>
- j) 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub>

All coating compositions with the exception of metallic coating d) were prepared from silicide powders that were prealloyed under conditions described in Section 3.2.1. The Mo-15.4Ti coatings were prepared from mechanically blended powders.



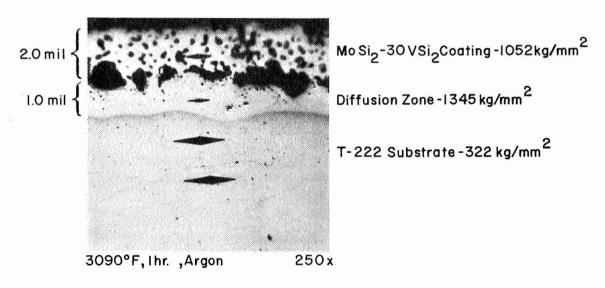


FIGURE 4

EFFECT OF SINTERING TEMPERATURE ON THE COATING STRUCTURE OF THE MoSi<sub>2</sub>-30VSi<sub>2</sub> COATING SYSTEM

### Siliconization Time

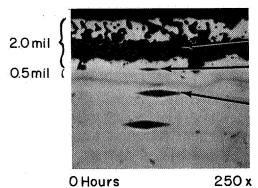
In this study the siliconization step of the coating process was optimized with respect to time in order to minimize the formation of TaSi2 in the coating system. For this investigation, a total of 21 coated T-222 specimens were electrophoretically prepared from each of the three MoSi2-base binary coating system, and each specimen was densified at 30 tsi and sintered at 2910°F (3090°F for the MoSi2-30VSi2 and MoSi2-30TiSi2 coatings) for 2 hours under argon. Seven specimens of each coating combination were exposed to a siliconization treatment at 2370°F under reduced pressure (100mm) for time intervals of 0, 4, and 8 hours. Photomicrographs showing the coating structure and hardness values of each siliconized group are shown in Figures 5 to 13. As shown in Figures 5 - 13 no appreciable variations in the depth of diffusion can be detected in the T-222 substrates as a result of the various siliconization treatments. In subsequent oxidation tests, however, the unsilicided specimens performed poorly compared to those that were silicided. Since no appreciable difference was noted in the oxidation life of the 4 and 8 hour siliconized specimens, the 8 hour siliconization treatment was arbitrarily considered optimum and was employed in siliconizing all subsequent silicide coatings prepared in this program.

### Preoxidation Time and Temperature

This study was concerned with establishing optimum preoxidation conditions that would extend the oxidation lives of the MoSi<sub>2</sub>-base coating systems at 1500°F and 2400°F. In this investigation the 8 hour-siliconized MoSi<sub>2</sub>-20TiSi<sub>2</sub> and MoSi<sub>2</sub>-10VSi<sub>2</sub> coatings and the 8 hour and a 16 hour-siliconized MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating systems were selected on the basis of their past oxidation performance.

The coated specimens for this study were prepared as follows:

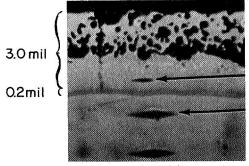
- a) The silicide coatings for the three coating combinations were electrophoretically deposited to a nominal 4.0 mil thickness which, upon sintering and siliciding, yielded a nominal 2.0 mil thick coating.
- b) All as-deposited coatings were densified at 10 tsi, preheated at 930°F under argon to drive off organics and subsequently sintered at 2910°F for 2 hours under argon.
- c) All sintered coatings were then silicided for 8 hours at 2370°F under reduced pressure.



Coating Pulled Out During Polishing

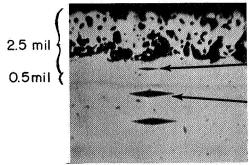
MoSi<sub>2</sub>-IOCrSi<sub>2</sub>Coating-I235 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate - 285 kg mm<sup>2</sup>(50gm Load)



4 Hours at 2370°F 250x 0.1 Torr

Mo Si<sub>2</sub>-IOCr Si<sub>2</sub>Coating-I235 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)

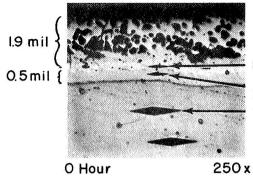


8Hours at 2370°F 250 x 0.1 Torr

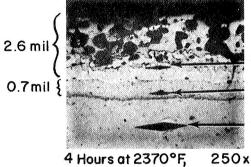
 $MoSi_2$ - $IOCrSi_2Coating$ - $I235 kg/mm^2$ (50gm Load) T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)

### FIGURE 5

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF  $MoSi_2-10CrSi_2$  COATING ON T-222 SINTERED AT 2910° F



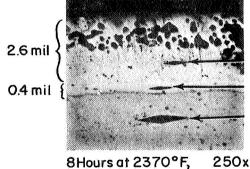
MoSi<sub>2</sub>-20CrSi<sub>2</sub>Coating-I235 kg/mm<sup>2</sup>(50gm Load)
Diffusion Zone-I235 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-322 kg/mm<sup>2</sup>(50gm Load)



O.I Torr

O.I Torr

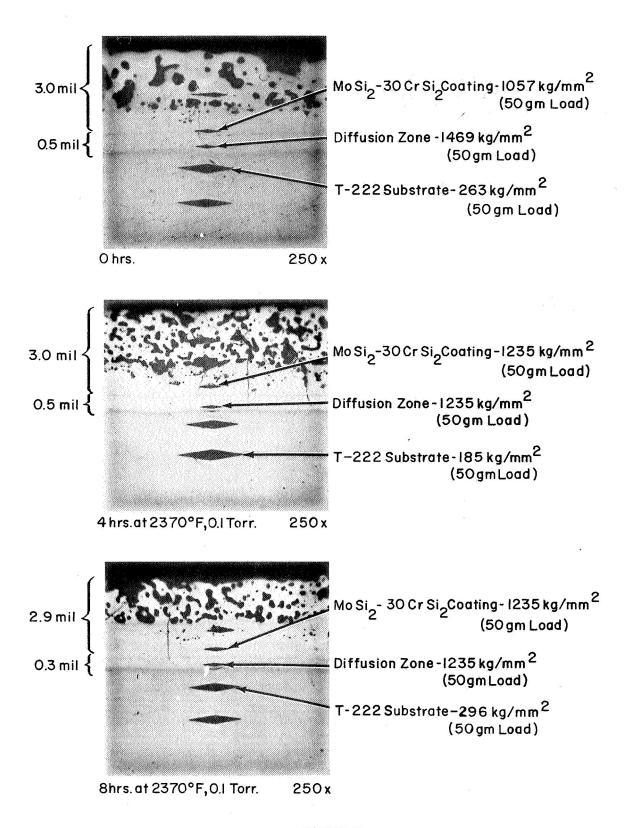
MoSi<sub>2</sub>-20CrSi<sub>2</sub>Coating-l052 kg/mm<sup>2</sup>(50gm Load)
Diffusion Zone - II38 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-285 kg/mm<sup>2</sup>(50gm Load)



MoSi<sub>2</sub>-20CrSi<sub>2</sub>Coating-1138 kg/mm<sup>2</sup>(50gm Load)
Diffusion Zone-1138 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-285 kg/mm<sup>2</sup>(50gm Load)

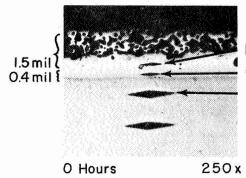
FIGURE 6

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-20CrSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F

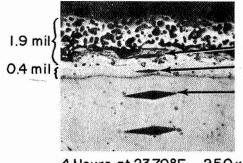


# FIGURE 7

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-30CrSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F

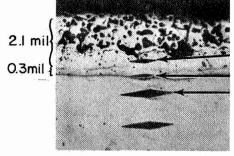


Mo Si<sub>2</sub>-10Ti Si<sub>2</sub>Coating - II38 kg/mm<sup>2</sup> (50 gm Load) Diffusion Zone - II38 kg/mm<sup>2</sup> (50 gm Load) T-222 Substrate - 322 kg/mm<sup>2</sup> (50 gm Load)



4 Hours at 2370°F, 250 x 0.1 Torr.

Mo Si<sub>2</sub>-IOTi Si<sub>2</sub>Coating-IO52kg/mm<sup>2</sup>(50gmLoad)
Diffusion Zone-II38kg/mm<sup>2</sup>(50gmLoad)
T-222 Substrate-322kg/mm<sup>2</sup>(50gmLoad)

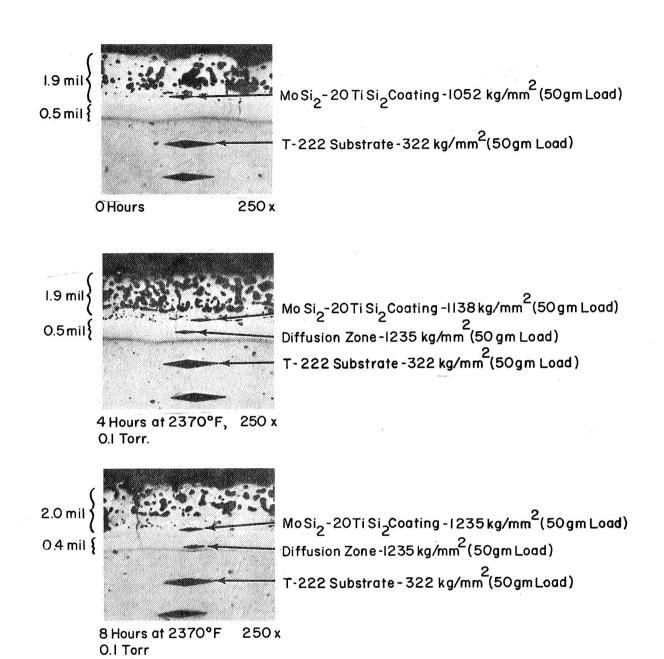


8 Hours at 2370°F, 250 x O.I Torr.

Mo Si<sub>2</sub>-10 Ti Si<sub>2</sub>Coating - 1052 kg/mm<sup>2</sup>(50gm Load)
Diffusion Zone - 1235 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate - 322 kg/mm<sup>2</sup>(50gm Load)

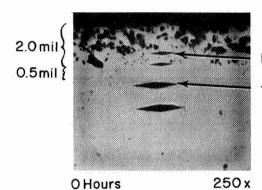
# FIGURE 8

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-10TiSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F

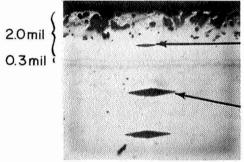


# FIGURE 9

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-20TiSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F



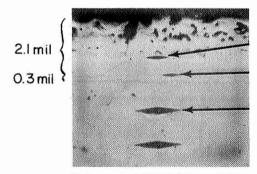
 $MoSi_2$ -30 Ti  $Si_2$ Coating-1235 kg/mm<sup>2</sup>(50gm Load) T-222 Substrate-285 kg/mm<sup>2</sup>(50gm Load)



4 Hours at 2370°F 250 x 0.1 Torr

MoSi<sub>2</sub>-30TiSi<sub>2</sub>Coating-1235kg/mm(50gm Load)

T-222 Substrate -  $285 \, \text{kg/mm}^2 (50 \, \text{gm Load})$ 



8 Hours at 2370°F 250 x 0.1 Torr

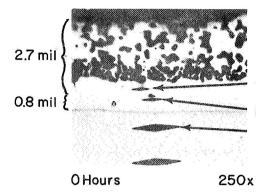
Mo Si<sub>2</sub> - 30 Ti Si<sub>2</sub>Coating - 1235kg/mm<sup>2</sup> (50gm Load)

Diffusion Zone - 1345 kg/mm<sup>2</sup> (50gm Load)

T-222 Substrate - 285 kg/mm<sup>2</sup> (50gm Load)

# FIGURE 10

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-30TiSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F

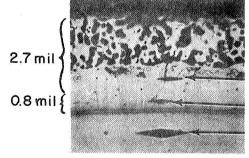


Mo Si<sub>2</sub>lovSi<sub>2</sub>Coating-IO52 kg mm<sup>2</sup>(50gm Load)
Diffusion Zone-II38 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-322 kg/mm<sup>2</sup>(50gm Load)

1.9 mil {
0.5 mil {

4 Hours at 2370°F, 250x 0.1 Torr

 $MoSi_2$ IOVSi<sub>2</sub>Coating-IO52 kg/mm<sup>2</sup>(50gmLoad) Diffusion Zone-I235 kg/mm<sup>2</sup>(50gm Load) T-222 Substrate - 322 kg/mm<sup>2</sup>(50gm Load)

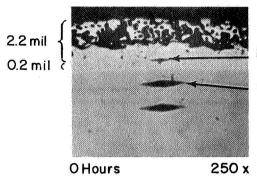


8 Hours at 2370°F, 250x 0.1 Torr

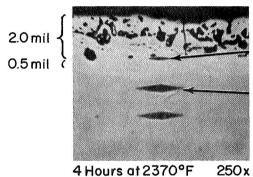
MoSi<sub>2</sub>-10VSi<sub>2</sub>Coating - 1052 kg/mm<sup>2</sup>(50gm Load)
Diffusion Zone - 1138 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate - 322 kg/mm<sup>2</sup>(50gm Load)

# FIGURE 11

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-10VSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F

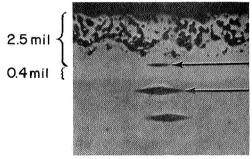


Mo Si<sub>2</sub>-20 V Si<sub>2</sub> Coating-1235 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-322 kg/mm<sup>2</sup>(50gm Load)



0.1 Torr

MoSi<sub>2</sub>-20VSi<sub>2</sub>Coating-II38 kg/mm<sup>2</sup>(50gm Load)
T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)

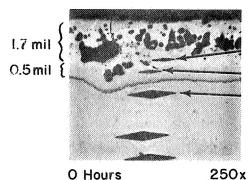


MoSi<sub>2</sub>-20VSi<sub>2</sub>Coating-II38 kg mm<sup>2</sup>(50gm Load) T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)

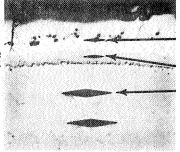
8 Hours at 2370°F 250x 0.1 Torr

#### FIGURE 12

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-20VSi<sub>2</sub> COATING ON T-222, SINTERED AT 2910°F



MoSi<sub>2</sub>-30VSi<sub>2</sub>Coating-1052 kg/mm<sup>2</sup>(50 gm Load)
Diffusion Zone -1235 kg/mm<sup>2</sup>(50 gm Load)
T-222 Substrate -285 kg/mm<sup>2</sup>(50 gm Load)



MoSi<sub>2</sub>-30VSi<sub>2</sub>Coating-IO52kg/mm<sup>2</sup>(50gmLoad)
Diffusion Zone-I235kg/mm<sup>2</sup>(50gmLoad)
T-222 Substrate - 325kg/mm<sup>2</sup>(50gmLoad)

4 Hours at 2370°F, 250 x 0.1 Torr





8 Hours at 2370°F 250x 0.1 Torr

MoSi<sub>2</sub>-30VSi<sub>2</sub>Coating-1075 kg/mm<sup>2</sup>(50 gm Load)
Diffusion Zone-1235 kg/mm<sup>2</sup>(50 gm Load)
T-222 Substrate-322 kg/mm<sup>2</sup>(50 gm Load)

#### FIGURE 13

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF MoSi<sub>2</sub>-30VS<sub>2</sub> COATING ON T-222, SINTERED AT 3090° F

- d) Seven specimens of each coating combination were finally preoxidized for 30 minutes at 2730°F, and 5, 15, and 30 minutes at 2910°F.
- e) Specimen weight gains were also recorded before and after siliciding and after each preoxidizing temperature and time interval.

Photographs depicting the coating structure and hardness values of each preoxidized system are shown in Figures 14 to 18.

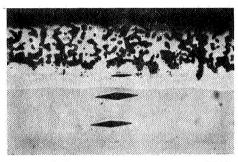
# Double Coating Application

In oxidation tests relating to the siliconization study (Section 3.3.1.), premature coating failure occurred at edges, corners or a localized surface site presumably due to undetectable point defects present in the coating system prior to testing. To test this assumption, the silicide coatings were deposited in two separate layers in the hope that the second layer would cover any defects present in the initial silicide layer. In this study, three coating systems (MoSi<sub>2</sub>-30CrSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub>, and MoSi<sub>2</sub>-10VSi<sub>2</sub>) were chosen for investigation on the basis of their past oxidation performance. Two coating layers for each system were applied electrophoretically to seven T-222 specimens to an overall nominal sintered thickness of 2.0 mils. The electrophoretically applied coatings were densified at 30 tsi and fired in argon at 2910°F for 1 hour. This treatment was repeated for each coating layer. The coated specimens were then siliconized at 2370°F for 8 hours under reduced pressure. Photomicrographs depicting the coating structure for these systems are shown in Figure 19.

# 3.3 Coating Evaluation Studies

# 3.3.1 Oxidation Tests of Selected Coating Systems Siliconized for Various Time Intervals

The MoSi<sub>2</sub>-base coating systems siliconized for various time intervals as described in Section 3.2.3 (Optimization of Process Parameters) were evaluated to determine their capability of providing the necessary oxidation protection to tantalum alloys at elevated temperatures. In this task, a total of 216 specimens of the various nine (9) coating combinations were satisfactorily prepared according to procedures described in Section 3.3.3 and screened in triplicate by cyclic testing at 1500°F and 2400°F. Testing was performed with the same type of quartz setter material and specimen arrangement that was used in Contract NAS 3-7613. The test arrangement is shown schematically in Figures 20 and 21.

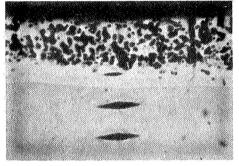


Preoxid. 5 mins. at 2910°F

MoSi<sub>2</sub>-IOVSi<sub>2</sub>Coating I235 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate - 322 kg/mm<sup>2</sup>(50gmLoad)



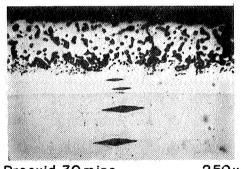


Preoxid.15 mins. at 2910° F

250 x

Mo Si<sub>2</sub>-IO V Si<sub>2</sub>Coating I235 kg/mm<sup>2</sup>(50 gm Load)

T-222 Substrate - 322 kg/mm<sup>2</sup> (50gm Load)



Preoxid.30 mins. at 2910° F

250x

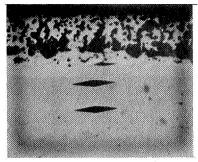
MoSi<sub>2</sub>-IOVSi<sub>2</sub>Coating

 $1235 \, \text{kg/mm}^2 (50 \, \text{gm Load})$ 

T-222 Substrate - 322 kg/mm<sup>2</sup> (50gm Load)

# FIGURE 14

MoSi<sub>2</sub>-10VSi<sub>2</sub> COATED T-222 SPECIMENS PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS

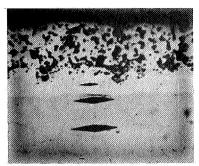


Preoxid.5mins. at 2910° F

250 x

 $1235 \text{ kg/mm}^2 (50 \text{gm Load})$ T-222 Substrate-322 kg/mm (50gm Load)

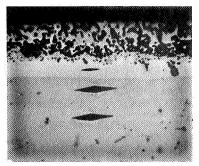
Mo Si<sub>2</sub>-20 Ti Si<sub>2</sub>Coating



Preoxid.15 mins. at 2910°F

250x

Mo Si<sub>2</sub>-20 Ti Si<sub>2</sub>Coating  $1235 \, \text{kg/mm}^2 (50 \, \text{gm Load})$ T-222 Substrate - 351 kg/mm<sup>2</sup> (50gm Load)



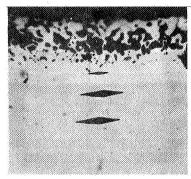
Preoxid. 30 mins. at 2910° F

250x

Mo Si<sub>2</sub>-20 Ti Si<sub>2</sub>Coating 1235 kg/mm<sup>2</sup>(50 gm Load) T-222 Substrate -322 kg/mm<sup>2</sup> (50gm Load)

# FIGURE 15

MoSi<sub>2</sub>-20TiSi<sub>2</sub> COATED T-222 SPECIMENS PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS

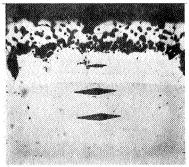


Preoxid. 5 mins. at 2910°F

Mo Si<sub>2</sub>-30 Cr Si<sub>2</sub>Coating 1235 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)





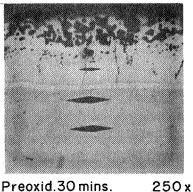
Preoxid.15 mins. at 2910° F

250 x

Mo Si<sub>2</sub>-30 Cr Si<sub>2</sub>Coating

1235 kg/mm<sup>2</sup>(50gm Load)

 $T\text{-}222\,\text{Substrate-}322\,\text{kg/mm}^2\text{(50gm\,Load)}$ 



Preoxid.30 mins. at 2910°F

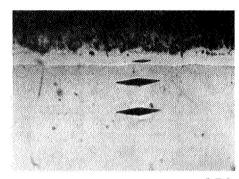
 $1235 \text{kg/mm}^2 (50 \text{gm Load})$ 

Mo Si<sub>2</sub>-30Cr Si<sub>2</sub>Coating

T-222 Substrate- 322 kg/mm<sup>2</sup>(50gm Load)

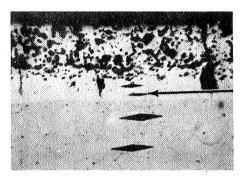
# FIGURE 16

 $MoSi_2-30CrSi_2$  COATED T-222 SPECIMENS PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS



Me Si<sub>2</sub>-10 V Si<sub>2</sub>Coating 1235 kg/mm<sup>2</sup>(50 gm Load) T- 222 Substrate-322kg/mm<sup>2</sup>(50gm Load)

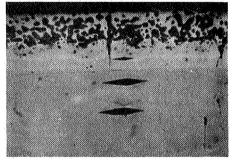
250x



Mo Si<sub>2</sub>-20 Ti Si<sub>2</sub>Coating-II38 kg/mm<sup>2</sup>(50gm Load)
I345 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate-322 kg/mm $^2$ (50gm Load)

250 x

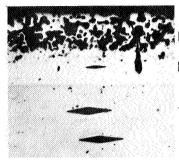


MoSi<sub>2</sub>-30CrSi<sub>2</sub>Coating 1235 kg/mm<sup>2</sup>(50gm Load) T-222 Substrate-309 kg/mm<sup>2</sup>(50gm Load)

250x

# FIGURE 17

MoSi<sub>2</sub>-10VSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub> AND MoSi<sub>2</sub>-30CrSi<sub>2</sub> COATED T-222 SPECIMENS PREOXIDIZED AT 2730°F FOR 30 MINUTES

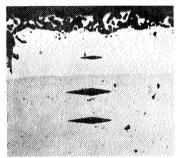


MoSi<sub>2</sub>-30CrSi<sub>2</sub>Coating 1235 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate-309 kg/mm<sup>2</sup> (50 g m Load)

Preoxid.5 mins at 2910°F

250x



Mo Si<sub>2</sub>-30 Cr Si<sub>2</sub>Coating 1235 kg/mm<sup>2</sup> (50 gm Load)

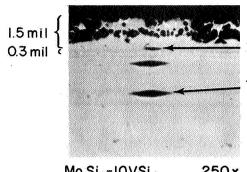
T-222 Substrate-322kg/mm<sup>2</sup> (50gm Load)

Preoxid.15 mins at 2910°F

250x

# FIGURE 18

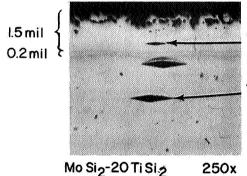
 ${
m MoSi_{z}}{
m -30CrSi_{z}}$  COATED T-222 SPECIMENS, SILICONIZED 16 HOURS, AND PREOXIDIZED AT 2910° FOR VARIOUS TIME INTERVALS



Mo Si<sub>2</sub>-10VSi<sub>2</sub>Coating -1345 kg/mm<sup>2</sup>(50gm Load) T-222 Substate -322 kg/mm<sup>2</sup>(50gm Load)

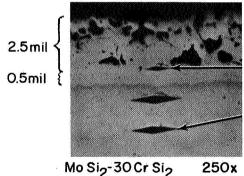
Mo Sig-10VSig

250 x



 $Mo Si_2$ -20Ti  $Si_2$ Coating - 1469 kg/mm<sup>2</sup> (50gm Load)

T-222 Substrate -322 kg/mm<sup>2</sup>(50gm Load)

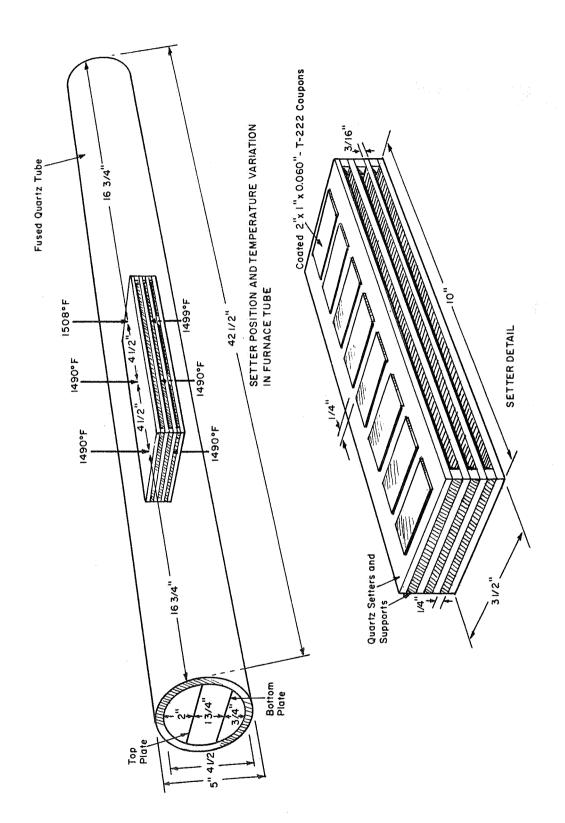


 ${\rm Mo\,Si_2}\text{--}30\,{\rm Cr\,Si_2}{\rm Coating\,-II38\,kg/mm_2(50gm\,Load)}$ 

T-222 Substrate-285 kg/mm<sup>2</sup>(50gm Load)

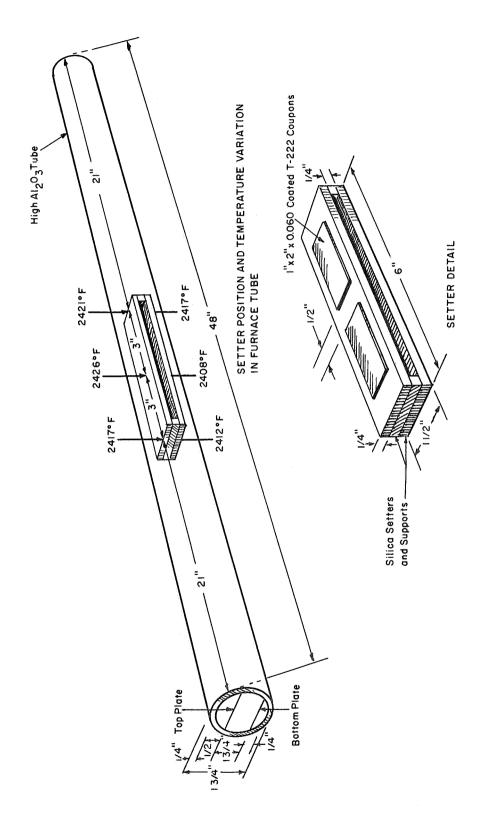
# FIGURE 19

STRUCTURE OF THE MoSi<sub>2</sub>-10VSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub> AND MoSi<sub>2</sub>-30CrSi<sub>2</sub> COATING SYSTEM APPLIED AS A DOUBLE COATING ON T-222



SPECIMEN ARRANGEMENT - 1500°F OXIDATION TEST

FIGURE 20



SPECIMEN ARRANGEMENT - 2400°F OXIDATION TEST

FIGURE 21

Although not indicated in the schematic drawings, the specimens in this program were raised from the setter plate by means of two 1/4 in x 1/4 in silica platelets placed at each end of the specimen, thus assuring approximately the same exposure conditions for both sides of the specimen during testing. The test cycles were every 2 hours during the work day with continuous testing overnight and during weekends. Deviations from the planned test cycles occurred on occasions during periodic maintenance of the furnaces.

The coating processing data and oxidation test results are tabulated for all specimens in Appendix A (pages A-1 to A-27) and are summarized in Figures 22 and 23. Photographs of the tested specimens are shown in Figures 24 through 32.

Of the coating systems investigated, the MoSi2-30CrSi2 exhibited the best oxidation performance at 1500°F and 2400°F irrespective of the siliconization treatment employed. All specimens but one (8 out of 9 tested) survived the 400 hour cyclic test at 1500°F. A single specimen failed at a localized corner site after 364 hours of testing.

At 2400°F one specimen from each siliconized group of three MoSi<sub>2</sub>-30CrSi<sub>2</sub> specimens survived 116 - 234 hours while the remaining specimens failed after 20 - 50 hours of cyclic testing.

Poorer oxidation performance was noted for the MoSiz-CrSiz coating system at lower concentration levels (10% and 20%) of CrSiz. The majority of specimens tested failed prematurely in less than 100 hours of testing. General failure occurred in most cases with the non-siliconized specimens while edge or corner failures were observed in the case of the siliconized specimens.

In the  $MoSi_2$ - $VSi_2$  coating system, the oxidation performance at  $1500^{\rm O}F$  was considered very poor regardless of the  $VSi_2$  concentration and siliconization time employed. All but one specimen failed within the first or second 2 hour cycle.

At 2400°F, the oxidation behavior of the MoSi2-VSi2 coating system was greatly improved by siliconization. The eight (8) hour-siliconized specimens performed the best, yielding oxidation lives of 406 hours for the three specimens tested. At VSi2 concentration levels of 20% and 30%, oxidation lives in the range of 2 - 26 and 4 - 170 hours respectively were obtained on both the four (4) and eight (8) hour siliconized specimens. It should also be noted that the MoSi2-30VSi2 coatings were approximately 2.5 mils thick compared to the 2.0 mil thick MoSi2-10VSi2 and MoSi2-20VSi2 coatings indicating that application of thicker coatings had no effect in promoting improved oxidation

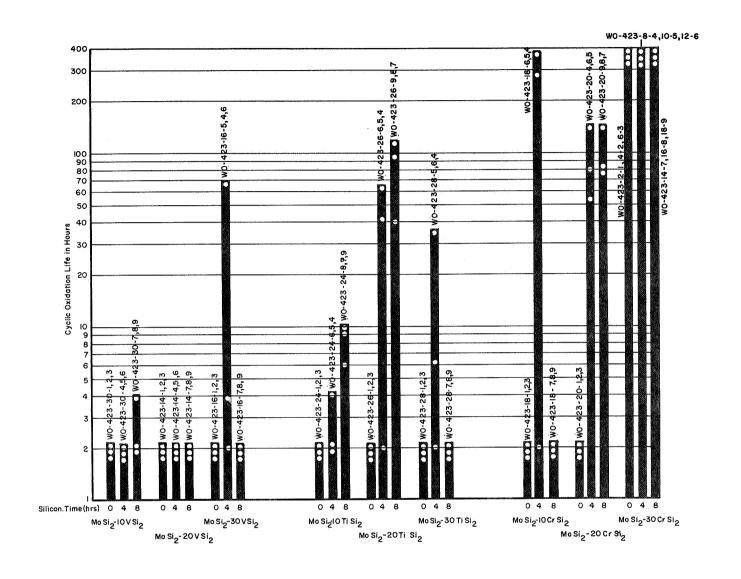


FIGURE 22

CYCLIC OXIDATION TEST RESULTS AT 1500°F OF THE VARIOUS MoSi<sub>2</sub> BASE COATING SYSTEMS SILICONIZED FOR VARIOUS TIME INTERVALS

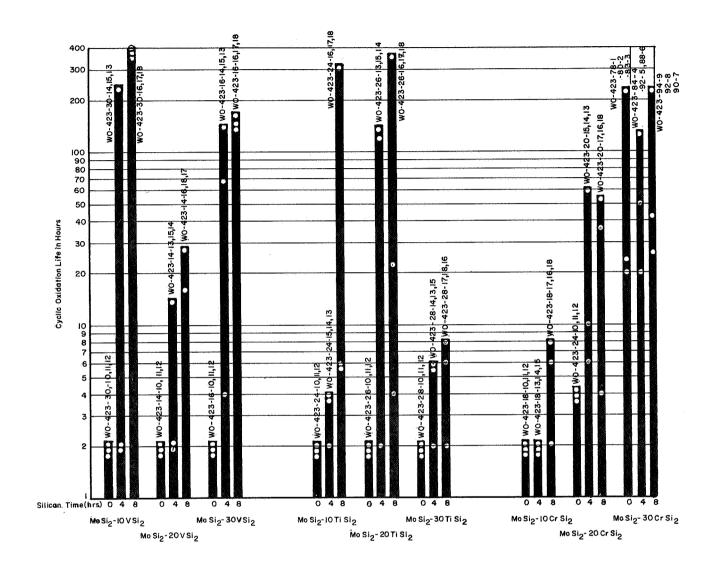
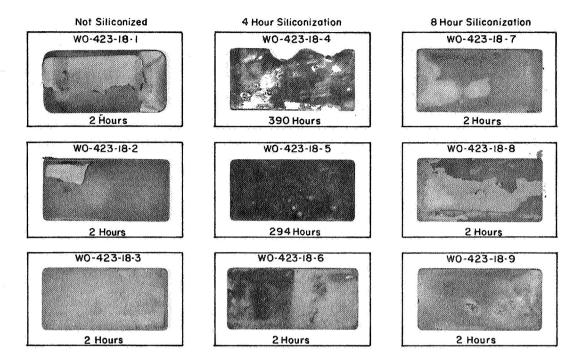


FIGURE 23

CYCLIC OXIDATION TEST RESULTS AT 2400°F OF THE VARIOUS MoSi<sub>2</sub> BASE COATING SYSTEMS SILICONIZED FOR VARIOUS TIME INTERVALS



# 2400°F OXIDIZED TEST SPECIMENS

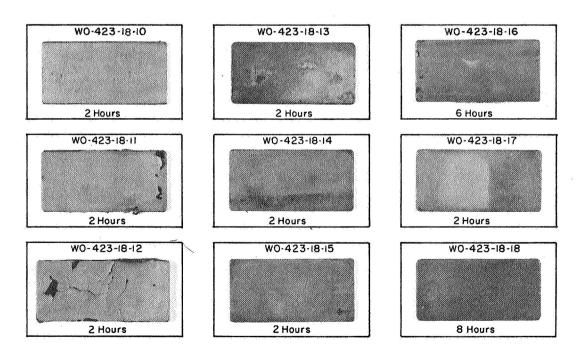
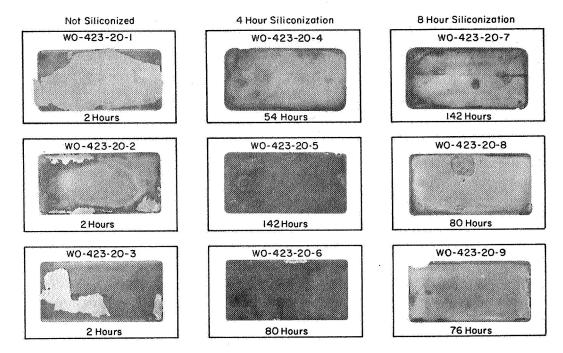


FIGURE 24

 $m MoSi_2-10CrSi_2$  COATED T-222 SPECIMENS SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



#### 2400°F OXIDIZED TEST SPECIMENS

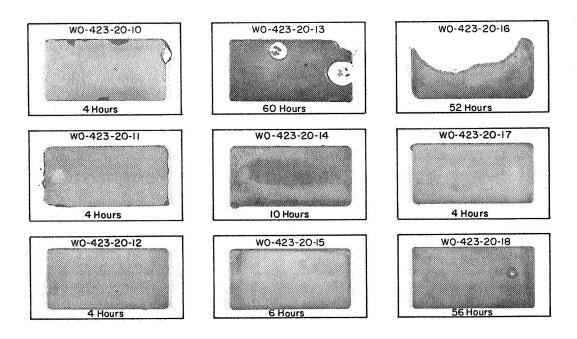
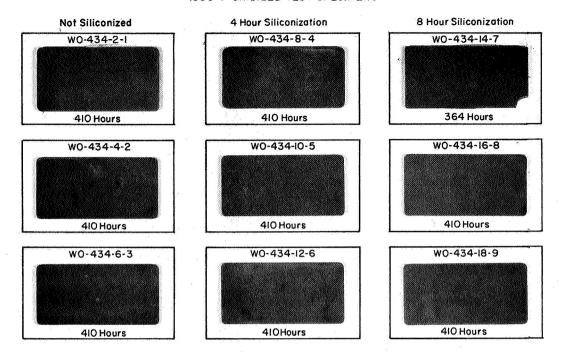


FIGURE 25

MoSi<sub>2</sub> -20CrSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



#### 2400°F OXIDIZED TEST SPECIMENS

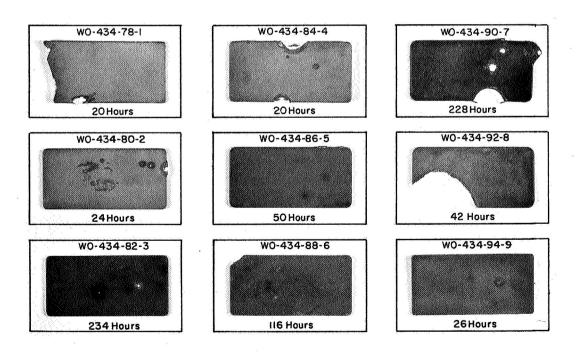
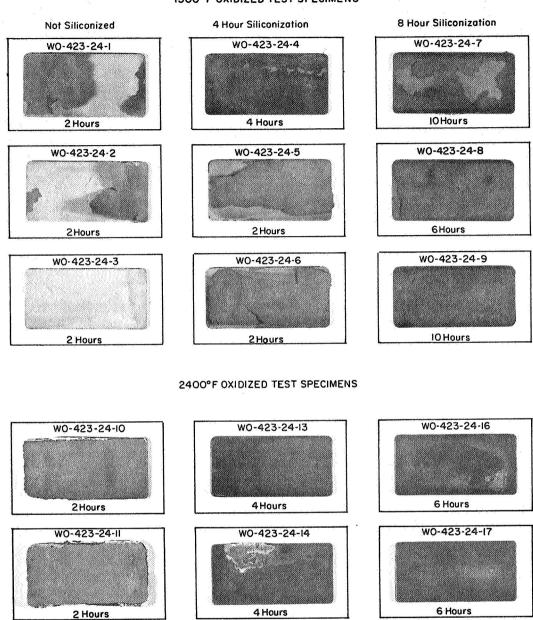


FIGURE 26

MoSi<sub>2</sub>-20CrSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



2 Hours 2 Hours

WO-423-24-12

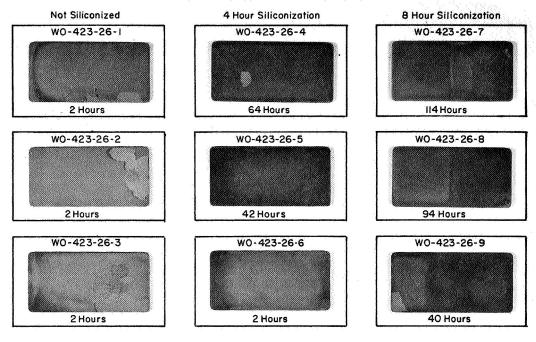
FIGURE 27

WO-423-24-I5

WO-423-24-18

320 Hours

MoSi<sub>2</sub>-10TiSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F and 2400°F



# 2400° F OXIDATION TEST SPECIMENS

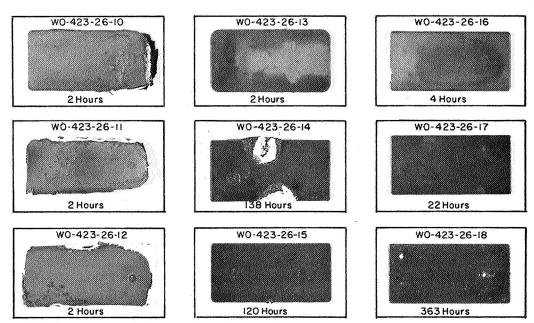
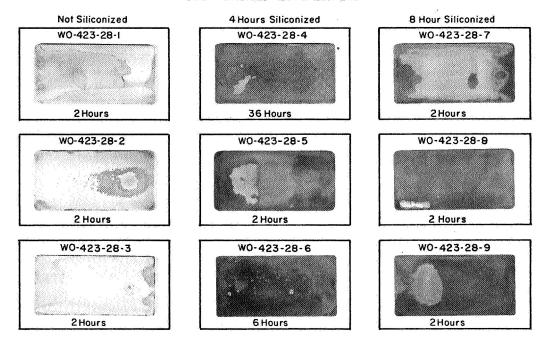


FIGURE 28

MoSi<sub>2</sub>-20 TiSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



## 2400°F OXIDIZED TEST SPECIMENS

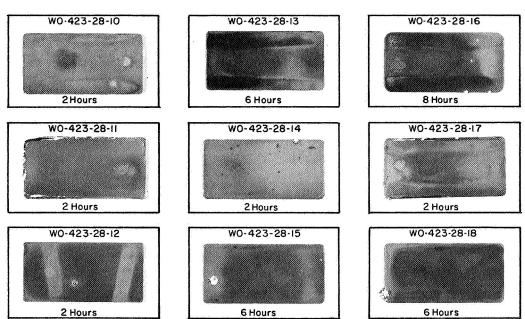
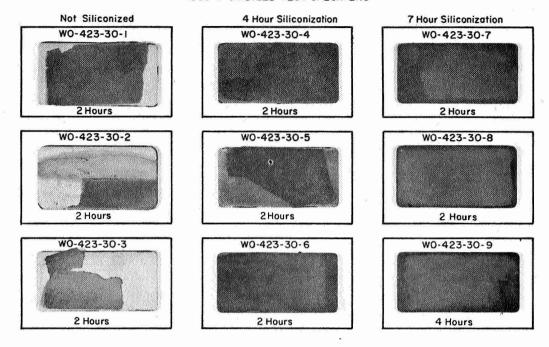


FIGURE 29

 $MoSi_2$ -30  $TiSi_2$  COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500° F AND 2400° F



# 2400°F OXIDIZED TEST SPECIMENS

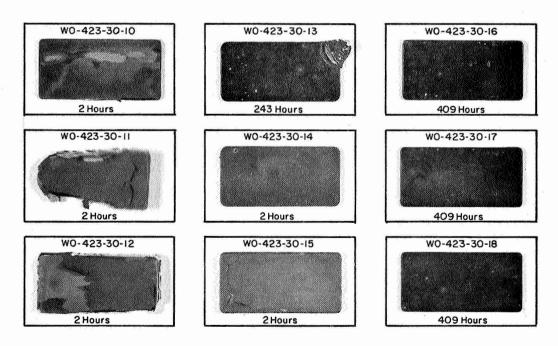
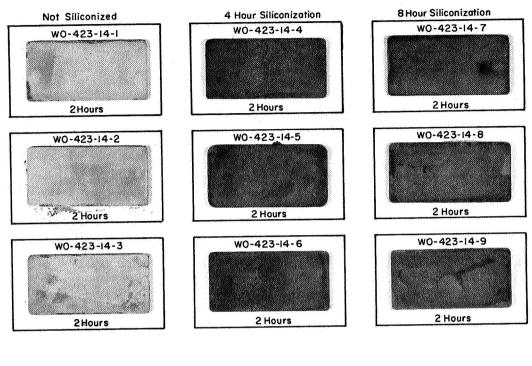


FIGURE 30

MoSi<sub>2</sub>-10 VSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



# 2400° OXIDIZED TEST SPECIMENS

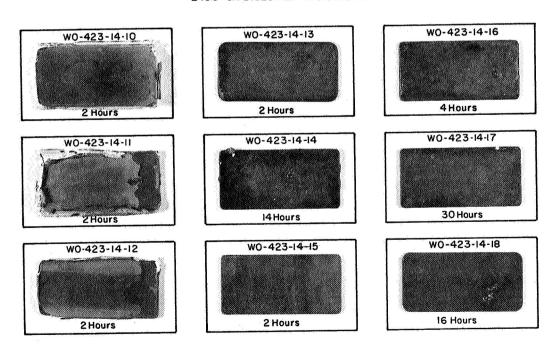
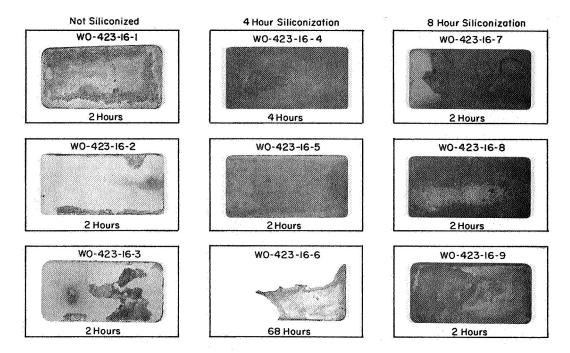


FIGURE 31

MoSi<sub>2</sub>-20VSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



#### 2400°F OXIDIZED TEST SPECIMENS

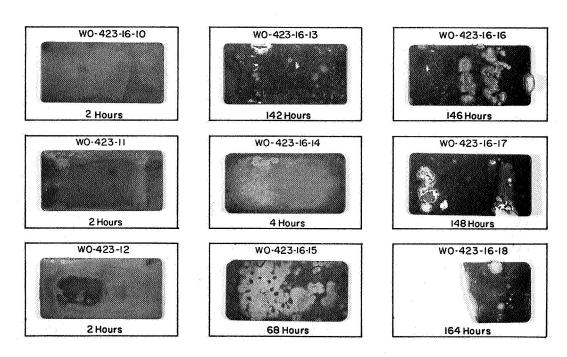


FIGURE 32

MoSi<sub>2</sub>-30VSi<sub>2</sub> COATED T-222, SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

resistance of this particular coating system. All specimens of the three VSi2 concentrations (10, 20 and 30%) that received no siliconization treatment failed after the first two (2) hour cycle. The oxidation performance of the MoSi2-TiSi2 coating system was also improved by a siliconization treatment. In this case, an eight (8) hour siliconization treatment appeared optimum, particularly with the MoSi2-10TiSi2 and MoSi2-20TiSi2 coating systems. Also, at the optimum siliconization condition and taking into account both test temperatures (1500°F and 2400°F) an optimum TiSi2 concentration level of 20% was indicated. Oxidation lives of 115 hours and 360 hours at 2400°F were realized. The non-siliconized specimens at the three TiSi2 concentration levels failed after the first two hour test cycle. Again, a general type of failure was noted with the non-siliconized specimens.

In examining the silicon weight gain data obtained for each specimen, considerable scatter was noted which precluded any correlation with oxidation resistance.

# 3.3.2 Oxidation Tests of Double-Coated Silicide Systems

For this evaluation the MoSi<sub>2</sub>-10VSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub> and MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating systems were used on the basis of their performance in previous tests. Three coated specimens of each coating system were tested under cyclic conditions at 1500°F and 2400°F. The results are tabulated in Appendix A (pages A-28 to A-30) and summarized in Figure 33. Photographs of the tested specimens are shown in Figures 34 to 36.

As indicated by the test results no improvement in oxidation life was obtained for the double coating systems. In fact, a single layer coating for each of the systems tested exhibited better oxidation resistance than the double layer coating. Microscopic examination of the double coated specimen failed to reveal the cause of premature coating failure. Of the eighteen specimens tested at 1500°F and 2400°F (6 for each coating system) sixteen failed after 2 - 48 hours of testing. Only one specimen from the MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating system survived the 400 hour test at 1500°F. The remaining specimen failed after 94 hours of testing at 2400°F.

# 3.3.3 Oxidation Tests of Preoxidized Silicide Coating Systems

In these tests, the effect of preoxidation on the oxidation behavior of the 8 hour-siliconized MoSi<sub>2</sub>-10VSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub>, and MoSi<sub>2</sub>-30CrSi<sub>2</sub> coatings and the 16 hour-siliconized MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating systems was determined. The 16 hour-siliconized MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating system was included in this

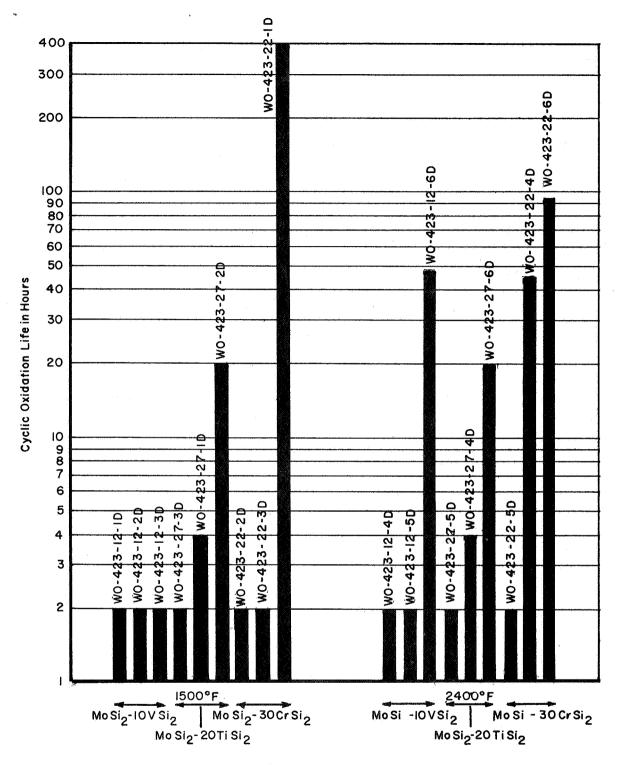
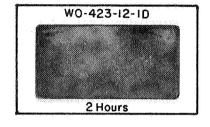
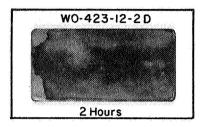


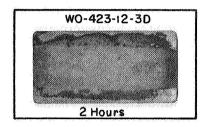
FIGURE 33

CYCLIC OXIDATION TEST RESULTS OF THE MoSi<sub>2</sub>-10VSi<sub>2</sub>, MoSi<sub>2</sub>-20TiSi<sub>2</sub> AND MoSi<sub>2</sub>-30CrSi<sub>2</sub> DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR 8 HOURS

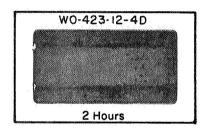
# I500°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization

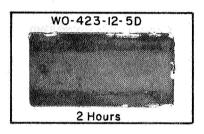






2400°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization





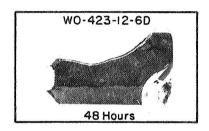
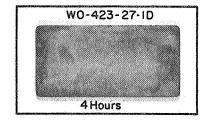
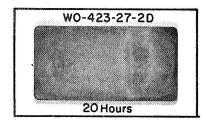


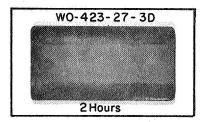
FIGURE 34

MoSi<sub>2</sub>-10VSi<sub>2</sub> DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR 8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

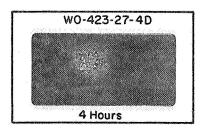
1500°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization

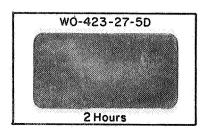






2400°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization





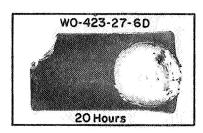
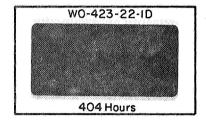
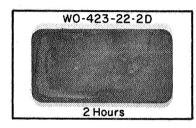


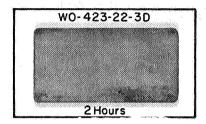
FIGURE 35

MoSi<sub>2</sub>-20TiSi<sub>2</sub> DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR 8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

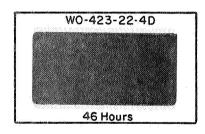
1500°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization

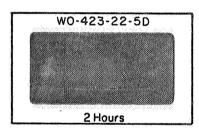






2400°F OXIDIZED TEST SPECIMENS 8 Hour Siliconization





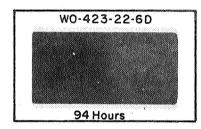


FIGURE 36

MoSi<sub>2</sub>-30CrSi<sub>2</sub> DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR 8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

investigation to determine the effect of combining a longer siliconizing treatment with preoxidation. In this study, preoxidation conditions of 30 minutes at 2730°F and 5, 15, and 30 minutes at 2910°F were examined. Specimen weight gain (mg/cm²) was determined before and after siliconizing and at each preoxidizing time interval (5, 10, and 30 minutes) at 2910°F. Three specimens from each coating combination were then oxidation tested at 1500°F and 2400°F. The results of these tests are summarized in Figures 37 to 38 and tabulated in Appendix A (pages A-31 to A-44). Photographs of each specimen after testing are shown in Figures 39 to 45.

The results of the oxidation tests indicate that preoxidation at the various time and temperature levels was not effective in improving the oxidation resistance of these silicide coating systems. The results were comparable to previous results obtained on specimens of the same coating system that were not preoxidized. The maximum oxidation life obtained for each coating system at 1500°F and 2400°F was as follows:

		Oxidation Life (hrs)	
Coating System	Preoxidation Conditions	1500°F	2400°F
· .			
MoSi2-10VSi2	5 minutes @ 2910°F	2	209
MoSi <sub>2</sub> -10VSi <sub>2</sub>	15 minutes @ 2910°F	2	318
MoSi2-10VSi2	30 minutes @ 2910°F	2	3 92
MoSi <sub>2</sub> -10VSi <sub>2</sub>	30 minutes @ 2700°F	22	22
MoSi <sub>2</sub> -20TiSi <sub>2</sub>	5 minutes @ 2910°F	69	162
MoSi <sub>2</sub> -20TiSi <sub>2</sub>	15 minutes @ 2910 <sup>0</sup> F	89	26
MoSi2-20TiSi2	30 minutes @ 2910°F	22	183
MoSi2-20TiSi2	30 minutes @ 2700°F	22	118
MoSi <sub>2</sub> -30CrSi <sub>2</sub> *	5 minutes @ 2910°F	164	139
MoSi <sub>2</sub> -30CrSi <sub>2</sub>	5 minutes @ 2910°F	460	142
MoSi <sub>2</sub> -30CrSi <sub>2</sub> *	15 minutes @ 2910°F	46	139
MoSi <sub>2</sub> -30CrSi <sub>2</sub>	15 minutes @ 2910°F	209	45
MoSi <sub>2</sub> -30CrSi <sub>2</sub>	30 minutes @ 2910°F	115	24
MoSi <sub>2</sub> -30CrSi <sub>2</sub>	30 minutes @ 2700°F	185	115

<sup>\*</sup>Coating system siliconized for 16 hours at 2370°F under reduced pressure.

As before, the MoSi<sub>2</sub>-30CrSi<sub>2</sub> coating system exhibited the best oxidation resistance at 1500°F while the MoSi<sub>2</sub>-10VSi<sub>2</sub> coating system yielded the best oxidation resistance at 2400°F.

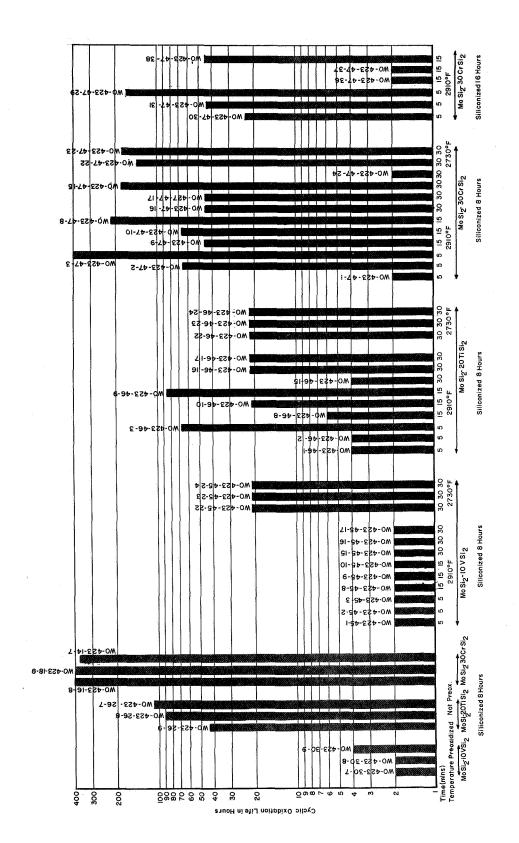
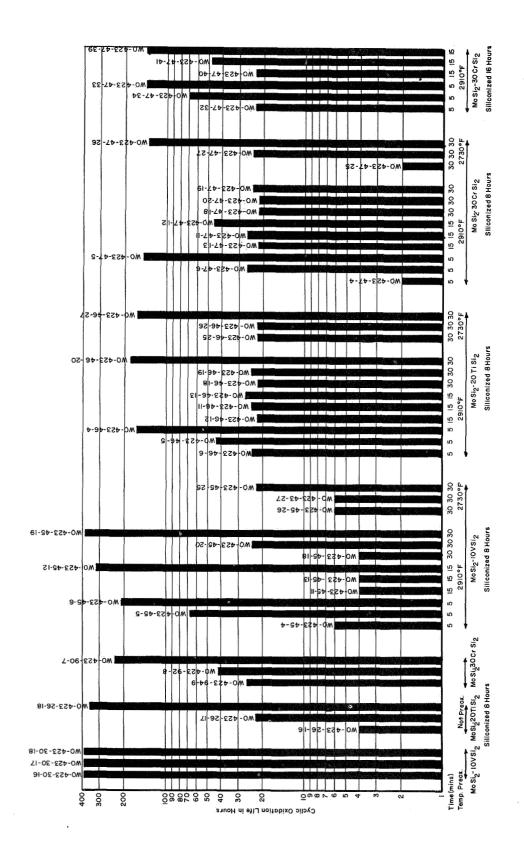


FIGURE 37

CYCLIC OXIDATION TEST RESULTS AT 1500°F OF THE VARIOUS SILICIDE COATED T-222 SPECIMENS PREOXIDIZED AT 2730°F AND 2910°F FOR VARIOUS TIME INTERVALS



CYCLIC OXIDATION TEST RESULTS AT 2400°F OF THE VARIOUS SILICIDE COATED T-222 SPECIMENS PREOXIDIZED AT 2730°F AND 2910°F FOR VARIOUS TIME INTERVALS

FIGURE 38

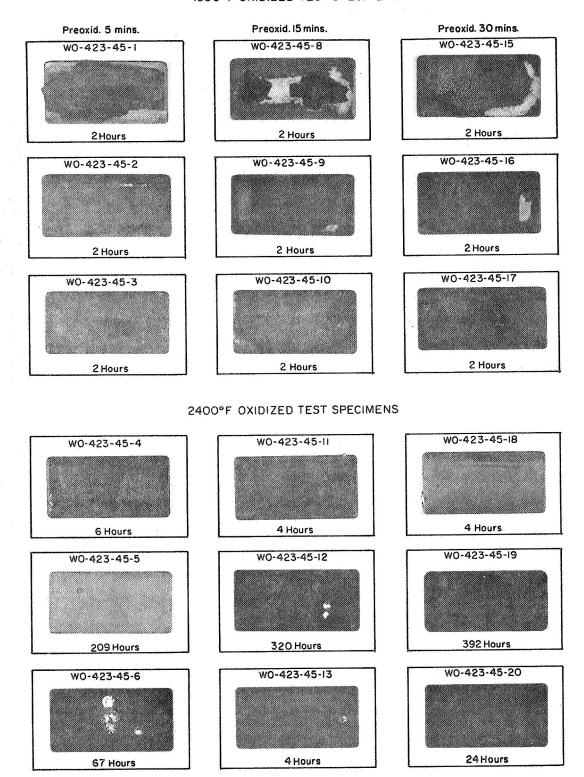
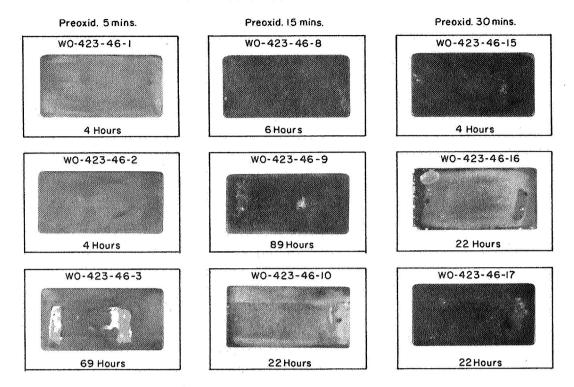


FIGURE 39

MoSi<sub>2</sub>-10VSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



#### 2400°F OXIDIZED TEST SPECIMENS

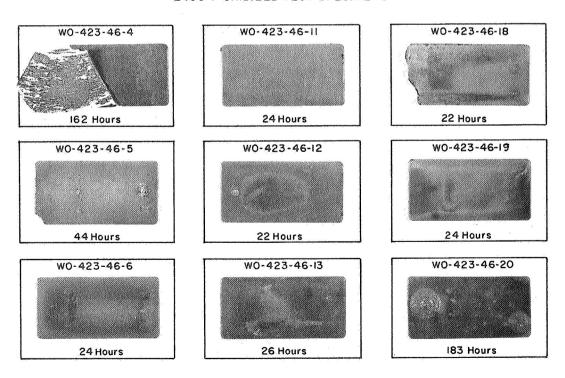
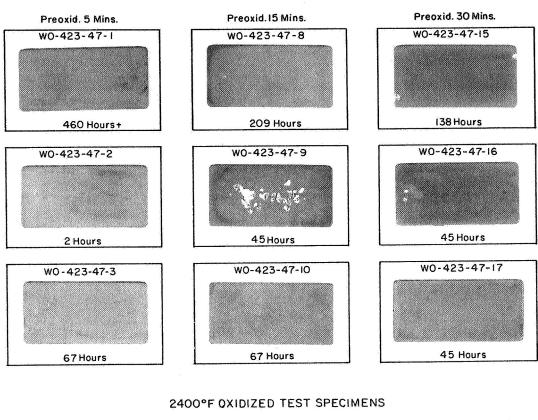


FIGURE 40

MoSi<sub>2</sub>-20TiSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



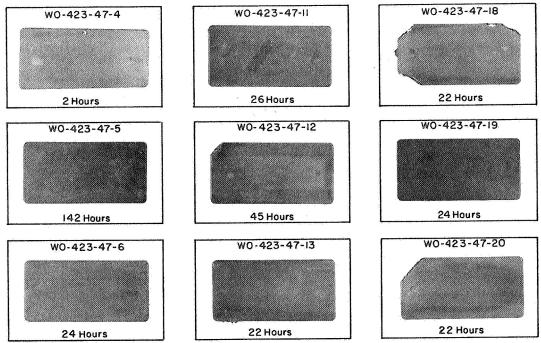
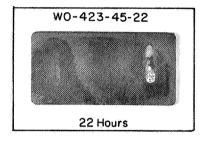
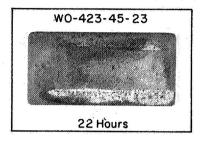
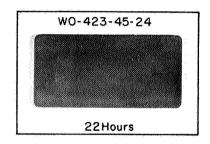


FIGURE 41

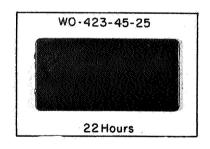
MoSi<sub>2</sub>-30CrSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2910°F FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

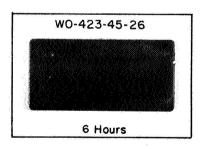






#### 2400°F OXIDIZED TEST SPECIMENS





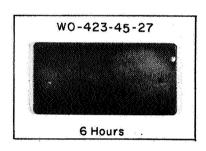
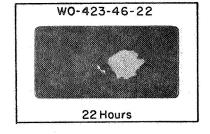
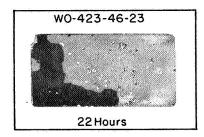
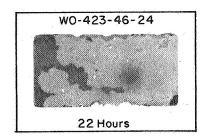


FIGURE 42

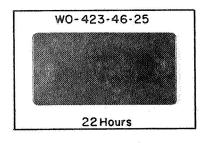
MoSi<sub>2</sub>-10VSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2730°F FOR 30 MINUTES AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

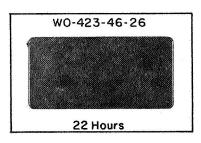






#### 2400°F OXIDIZED TEST SPECIMENS





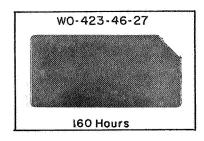
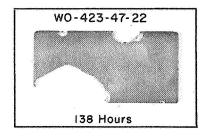
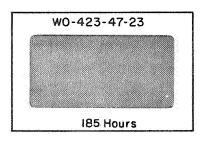
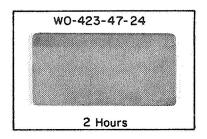


FIGURE 43

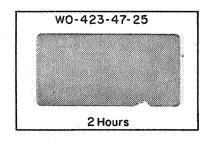
MoSi<sub>2</sub>-20TiSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2730°F FOR 30 MINUTES AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

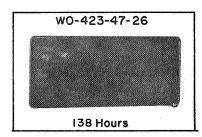






#### 2400°F OXIDIZED TEST SPECIMENS





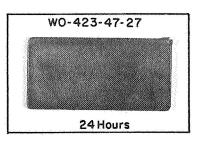
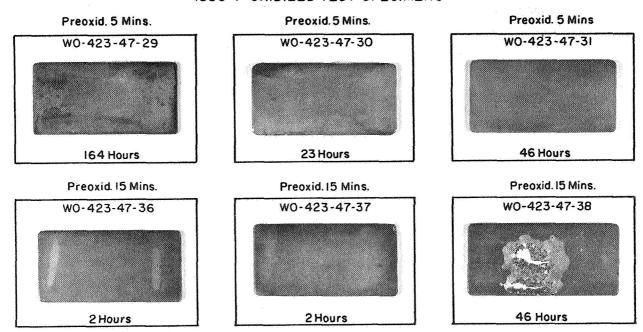


FIGURE 44

MoSi<sub>2</sub> -30CrSi<sub>2</sub> COATED T-222 PREOXIDIZED AT 2730° F FOR 30 MINUTES AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400° F



#### 2400° F OXIDIZED TEST SPECIMENS

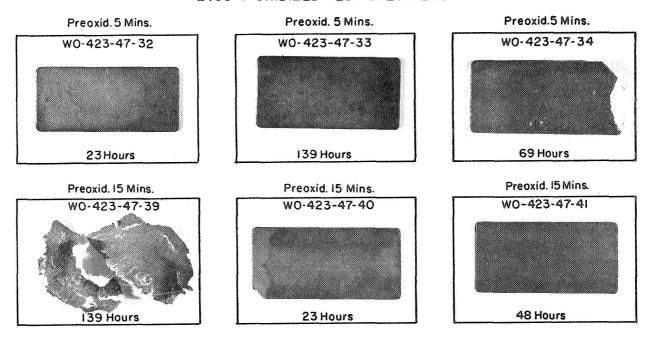


FIGURE 45

MoSi<sub>2</sub>-30CrSi<sub>2</sub> COATED T-222 SPECIMENS SILICONIZED FOR 16 HOURS PREOXIDIZED AT 2910° F FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500° F AND 2400° F

## 3.4.4 Oxidation Tests of the Siliconized Mo-15.4Ti Coating System

In an effort to improve the coating reliability of the MoSi<sub>2</sub> base coating systems, an attempt was made to prepare the MoSi<sub>2</sub>-20TiSi<sub>2</sub> coating system by a technique whereby the density of the coating could be increased and thus possibly result in improved oxidation resistance. In this approach molybdenum and titanium metal powders were codeposited from a Mo-15.4%Ti metal powder dispersion, densified at 30 tsi, and sintered at 2910°F for 3 hours under reduced pressure (0.01 micron). A duplicate set of test specimens was also sintered at 3630°F for the same interval. All specimens were siliconized for 16 hours at 2370°F under reduced pressures and then cyclic oxidation tested at 1500°F and 2400°F. The results of these tests are tabulated in Appendix A (pages A-45 to A-47) and also shown in Figure 46. Photographs of the tested specimens are shown in Figures 47 and 48.

Photomicrographs depicting the coating structure of the sintered and siliconized coatings are shown in Figures 49 and 50.

As the results indicate, improvement in oxidation behavior over previously tested specimens of the MoSi2-20TiSi2 coating system was not obtained. The only difference observed in this series of tests was between the 2910°F and 3630°F sintered specimens. Longer lives (68-416 hours) were obtained at 1500°F on specimens that were sintered at the higher temperature (3630°F). The maximum life achieved with the 2910°F sintered specimens at the 1500°F test temperature was 23 hours.

At 2400°F all of the specimens with the exception of one failed between the first and third 2-hour cycle. The longer-lived specimen, which was sintered at the higher sintering temperature, failed after 92 hours of testing. These results indicated that a denser coating structure was ineffective in extending the oxidation life of the MoSi<sub>2</sub>-20TiSi<sub>2</sub> coating system.

## 3.3.5 Oxidation Tests of the CrSi<sub>2</sub>-20TiSi<sub>2</sub> Binary and MoSi<sub>2</sub> 15CrSi<sub>2</sub>-15VSi<sub>2</sub> Ternary Coating System

In another approach to meet the program objective, prealloyed CrSi<sub>2</sub>-20VSi<sub>2</sub> and MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub> systems were investigated for protecting tantalum alloy. Coatings for these systems were prepared by sintering the densified, electrophoretically deposited coating at 2910°F for 1 hour under argon and subsequently siliconizing at 2370°F for 8 hours under reduced pressure. Photomicrographs showing the coating structure of these two systems are shown in Figures 51 and 52. For these tests, six (6) specimens of each

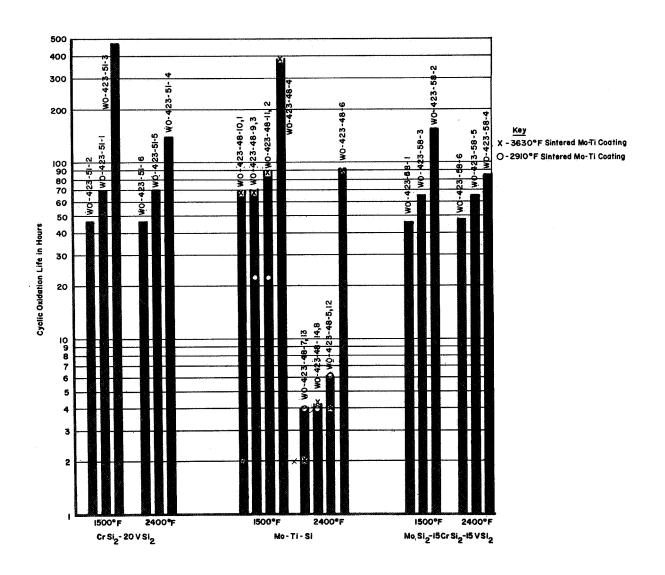


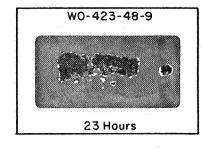
FIGURE 46

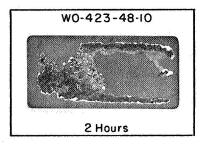
CYCLIC OXIDATION TEST RESULTS OF THE CrSi<sub>2</sub>-20VSi<sub>2</sub>, MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub> AND THE Mo-15.4Ti-Si COATED T-222 SPECIMENS

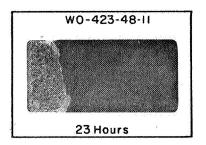
1500°F 2400°F OXIDIZED TEST SPECIMENS OXIDIZED TEST SPECIMENS WO-423-48-1 WO-423-48-5 70 Hours 4 Hours WO-423-48-2 WO-423-48-6 88 Hours 92 Hours WO-423-48-7 WO-423-48-3 68 Hours 2 Hours WO-423-48-4 WO-423-48-8 416+Hours 4 Hours

FIGURE 47

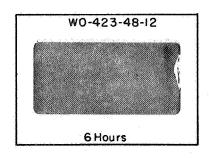
Mo-15,4Ti COATED T-222 SPECIMENS' SINTERED AT 3630°F, SILICONIZED FOR 16 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

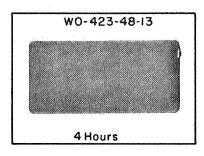






#### 2400°F OXIDIZED TEST SPECIMENS





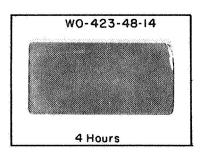
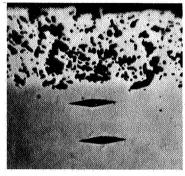


FIGURE 48

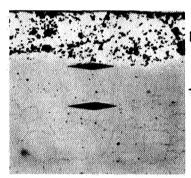
Mo-15.4Ti COATED T-222 SPECIMENS, SINTERED AT 2910°F, SILICONIZED FOR 16 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F



Mo-15.4 Ti Coating

T-222 Substrate - 309 kg/mm<sup>2</sup> (50 gm Load)

Sintered at 2910°F 250x



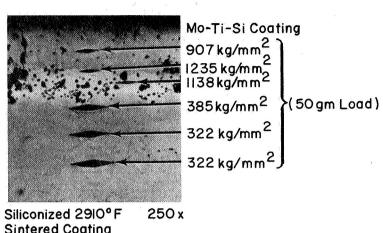
Mo-15.4 Ti Coating

T-222 Substrate-309 kg/mm<sup>2</sup> (50 gm Load)

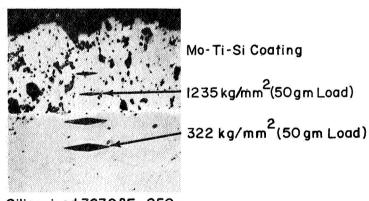
Sintered at 3630°F 250 x

#### FIGURE 49

Mo-15.4Ti COATED T-222 SPECIMENS, SINTERED AT 2910° F AND 3630° F UNDER REDUCED PRESSURE



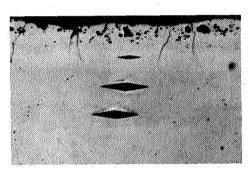
Sintered Coating



Siliconized 3630°F 250x **Sintered Coating** 

#### FIGURE 50

Mo-15.4Ti COATED T-222 SPECIMENS SINTERED AT 2910°F AND 3630°F, AND SILICONIZED FOR 16 HOURS AT 2370°F UNDER REDUCED PRESSURE

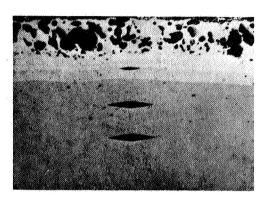


Cr Si<sub>2</sub>-20 VSi<sub>2</sub>Coating II38 kg/mm<sup>2</sup>(50gm Load) T-222 Substrate 309 kg/mm<sup>2</sup> (50gm Load)

250x

## FIGURE 51

CrSi<sub>2</sub>-20VSi<sub>2</sub> COATED T-222 SPECIMENS, SINTERED AT 2910°F AND SILICONIZED AT 2370°F FOR 8 HOURS UNDER REDUCED PRESSURE



Mo Si<sub>2</sub>-15Cr Si<sub>2</sub>-15 VSi<sub>2</sub>Coating
Diffusion Zone-1638 kg/mm<sup>2</sup>
(50gm Load)
T-222 Substrate - 336 kg/mm<sup>2</sup>
(50gm Load)

250 x

#### FIGURE 52

MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub> COATED T-222 SPECIMENS, SINTERED AT 2910°F AND SILICONIZED AT 2370°F FOR 8 HOURS UNDER REDUCED PRESSURE

coating system were prepared and cyclic tested at 1500°F and 2400°F. The results for both coating systems are summarized in Figure 46. The results are also tabulated in Appendix A (pages A-48 and A-49). Photographs of the tested specimens are shown in Figures 53 and 54.

The oxidation performance of the CrSi<sub>2</sub>-20VSi<sub>2</sub> was the better of the two; exhibiting oxidation lives of 46 - 466 hours at 1500°F and 46 - 100 hours at 2400°F, as compared to 46 - 156 hours at 1500°F and 48 - 86 hours at 2400°F for the ternary MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub> coating system. Although most of the specimens tested from these coating combinations did not satisfy the specified test duration of 400 hours at both test temperatures, they did show a pronounced improvement in reliability over coating systems tested previously.

#### 3.3.6 Oxidation Tests of the Quaternary MoSi2-WSi2-TiSi2-VSi2

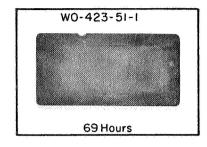
#### Coating System

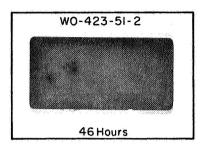
Two quaternary coating systems; namely, 35MoSi2-35WSi2-15TiSi2-15VSi2, and 33.6MoSi2-27.6WSi2-19.7TiSi2-19.1VSi2 were evaluated for tantalum alloy protection at 1500°F and 2400°F. The latter composition corresponded to Solar's(3) TNV-7 coating composition after complete siliconization. Coatings of these systems were prepared as described in Section 3.2.2 and cyclic oxidation tested at 1500°F and 2400°F. The results are tabulated in Appendix A (pages A-50 and A-51) and also summarized in Figure 55. Photomicrographs depicting the coating structure of both coating systems are shown in Figure 56. Photographs of the tested specimens are shown in Figures 57 and 58. Both coating systems exhibited very poor oxidation behavior at both test temperatures. Oxidation lives of 52 hours or less were obtained. Failure occurred in all cases at the edge of the specimen. In some cases a surface type failure was also noted.

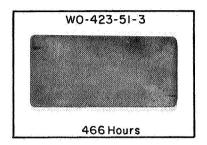
### 3.3.7 Oxidation Tests of MoSi<sub>2</sub>-Base Coatings Over a VSi<sub>2</sub>

#### Barrier Layer

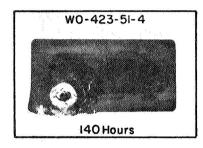
In this task, a two-layer silicide coating system was examined which showed promise for protecting tantalum T-222 at  $1500^{\circ}F$  and  $2400^{\circ}F$ . This coating system consisted of a nominal 2.0 mil thick  $MoSi_2-30CrSi_2$  outer coating applied over a nominal 1.0 mil thick  $VSi_2$  inner coating on T-222. Each coating layer was deposited separately and sintered at  $2910^{\circ}F$  for 1 hour under argon. The  $VSi_2$  coating was sintered without pressing, and the  $MoSi_2-30CrSi_2$  coating was densified at 10 tsi prior to sintering. The dual coating system was then siliconized for 8 hours at  $2370^{\circ}F$  under reduced pressure and finally cyclic oxidation tested at  $1500^{\circ}F$  and  $2400^{\circ}F$ .

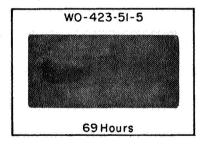






#### 2400°F OXIDIZED TEST SPECIMENS





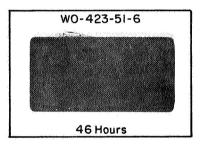
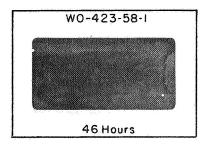
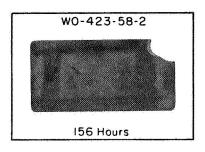
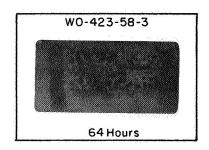


FIGURE 53

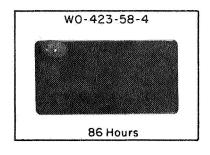
CrSi<sub>2</sub>-20VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

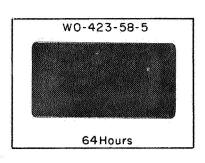






#### 2400°F OXIDIZED TEST SPECIMENS





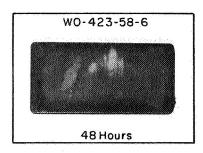


FIGURE 54

MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub> COATED T-222 SPECIMENS CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

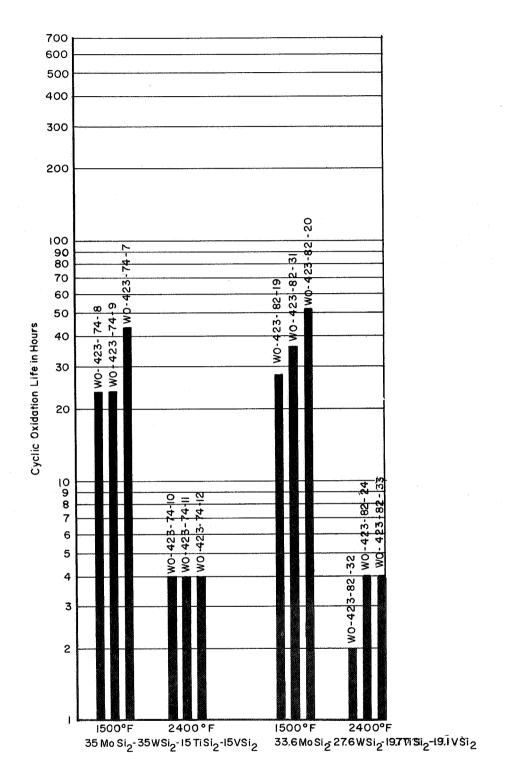
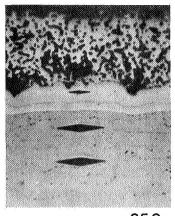


FIGURE 55

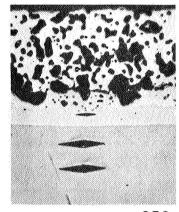
OXIDATION TEST RESULTS OF THE MoSi<sub>2</sub>-WSi<sub>2</sub>-TiSi<sub>2</sub>-VSi<sub>2</sub>
COATINGS ON T-222 AT 1500°F AND 2400°F
UNDER CYCLIC CONDITIONS



35 MoSi<sub>2</sub>-35 WSi<sub>2</sub>-15 TiSi<sub>2</sub>-15 VSi<sub>2</sub> Coating 1215 kg/mm<sup>2</sup> (50gm Load)

T-222 Substrate-292kg/mm<sup>2</sup>(50gm Load)

250x



 $33.6\,\mathsf{MoSi}_2\text{-}27.6\,\mathsf{WSi}_2\text{-}19.7\,\mathsf{Ti}\,\mathsf{Si}_2\text{-}19.1\,\mathsf{V}\,\mathsf{Si}_2\mathsf{Coating}$ 

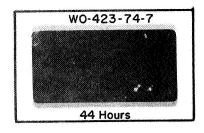
Diffusion Zone-1310 kg/mm<sup>2</sup> (50gm Load)

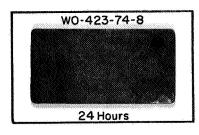
T-222 Substrate - 313 kg/mm<sup>2</sup> (50gm Load)

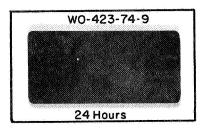
250x

FIGURE 56

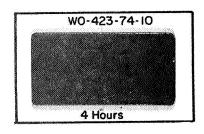
SINTERED AND SILICONIZED MoSi<sub>2</sub>-WSi<sub>2</sub>-TiSi<sub>2</sub>-VSi<sub>2</sub>
COATED T-222 SPECIMEN

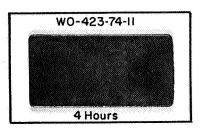






#### 2400°F OXIDIZED TEST SPECIMENS





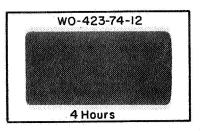
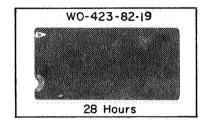
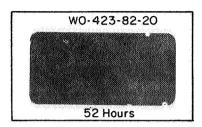
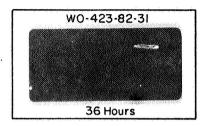


FIGURE 57

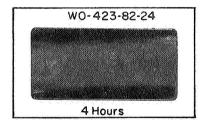
35 MoSi<sub>2</sub> - 35 WSi<sub>2</sub> - 15 TiSi<sub>2</sub> - 15 VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

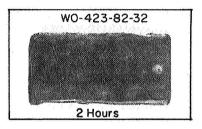






#### 2400°F OXIDIZED TEST SPECIMENS





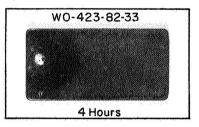


FIGURE 58

33.6 MoSi<sub>2</sub>-27.6 WSi<sub>2</sub>-19.7 TiSi<sub>2</sub>-19.1 VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

A photomicrograph depicting the coating structure of this coating combination is shown in Figure 59. The results of these cyclic oxidation tests are tabulated in Appendix A (page A-52) and summarized in Figure 60. Photographs of the tested specimens are shown in Figure 61.

As indicated in Figure 60, two specimens of this coating system passed the 400 hour cyclic test at 1500°F. The third specimen tested failed after 252 hours of testing at a site where the VSi2 underlay coating was not patched.

At 2400°F, oxidation lives in the range of 90 - 138 hours were obtained. Failure occurred in the same location as in the 1500°F test.

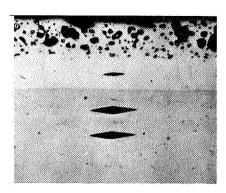
In view of these results, a duplicate set of specimens was prepared and oxidation tested. Special attention was given to the "patching" operation for each coating application. Also included in the 2400°F test were three additional MoSi2-30CrSi2/VSi2 coated specimens that were given a 5 minute preoxidation treatment at 2910°F.

Results obtained on this set of specimens were very encouraging and are also shown in Figure 60 and tabulated in Appendix A (pages A-53 and A-54). Photographs of the tested specimens are shown in Figure 62.

At 1500°F, two of the three specimens tested survived 406 hours of testing without failure whereas the third specimen failed at a corner site after 244 hours of testing.

At 2400°F, one preoxidized specimen survived 366 hours of cyclic testing with failure occurring at the flat surface of the specimen. The remaining specimens (duplicate group and preoxidized group) failed prematurely after 48 - 244 hours of cyclic testing at either a patch, corner, edge, or surface site.

Although this coating system did not pass the 2400°F test, an improvement in oxidation behavior (more reliability and longer oxidation lives) was evident when compared to oxidation data obtained from the various coating systems tested previously. In view of this development, additional tests were designed and conducted on two additional coating combinations to determine the optimum relative layer thickness required to yield the desired oxidation resistance. For this study, a MoSi2-20TiSi2/VSi2 and a MoSi2-40CrSi2/VSi2 coating combination were selected.



Mo Si<sub>2</sub>-30Cr Si<sub>2</sub>Coating
V Si<sub>2</sub>Coating-1235 kg/mm<sup>2</sup>
(50 gm Load)
T-222 Substrate-309 kg/mm<sup>2</sup>
(50 gm Load)

250 x

#### FIGURE 59

MoSi<sub>2</sub>-30CrSi<sub>2</sub>/VSi<sub>2</sub> COATED T-222 SPECIMENS SINTERED AT 2910°F AND SILICONIZED AT 2370°F FOR 8 HOURS UNDER REDUCED PRESSURE

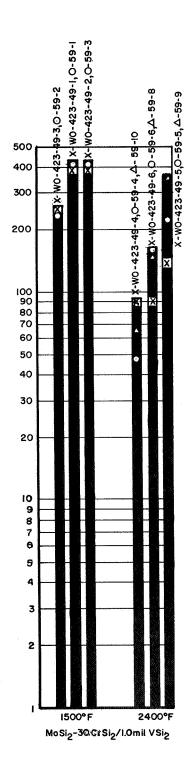
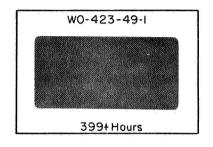
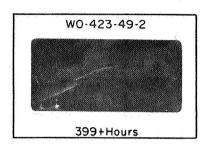
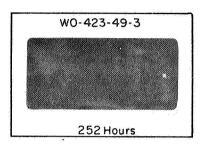


FIGURE 60

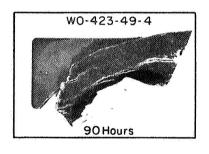
CYCLIC OXIDATION TEST RESULTS OF THE MoSi<sub>2</sub>-30CrSi<sub>2</sub>/
VSi<sub>2</sub> COATED T-222 SPECIMENS

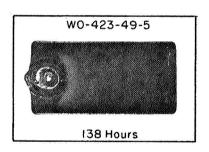






#### 2400°F OXIDIZED TEST SPECIMENS





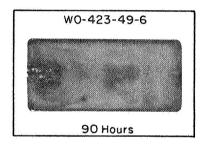
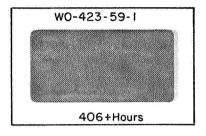
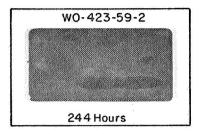
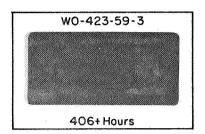


FIGURE 61

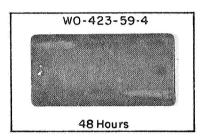
MoSi<sub>g</sub>-30CRSi<sub>g</sub>/VSi<sub>g</sub> COATED T-222 SPECIMENS CYCLIC OXIDATION TESTED AT 1500°F AND 2400° F

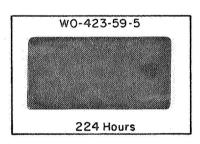


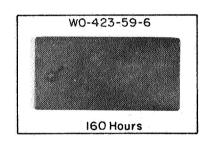


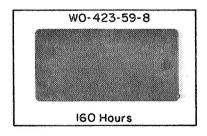


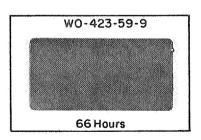
#### 2400°F OXIDIZED TEST SPECIMENS











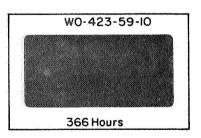


FIGURE 62

 $MoSi_2-30CrSi_2/VSi_2$  COATED T-222 SPECIMENS CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

A total of six (6) T-222 specimens (2 in x 1 in x 0.060 in) were coated with each of the following coatings and cyclic tested at 1500°F and 2400°F:

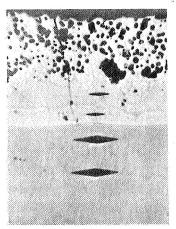
- a) 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub>
- b) 1.0 mil MoSi2-20TiSi2/1.5 mil VSi2
- c) 2.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/0.5 mil VSi<sub>2</sub>
- d) 1.0 mil MoSi2-40CrSi2/1.5 mil VSi2

Photomicrographs depicting the coating structure of these two systems are shown in Figures 63 and 64. The oxidation test results obtained on these coating systems together with test results obtained previously on the 1.5 mil MoSi2-30CrSi2/1.0 mil VSi2 coating system are summarized in Figure 65 and tabulated in Appendix A (pages A-55 to A-58). Photographs of the tested specimens are shown in Figures 66 to 69.

Of the coatings tested, the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> (both thickness ratios) and the 1.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coated T-222 specimens yielded the best oxidation test results at test temperatures of 1500°F and 2400°F. At 1500°F, two of the three specimens of the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> coating system survived the 400 hour cyclic test. One specimen lasted 400 hours and the other 1350 hours (extended testing) without failing. The third specimen of this group of three exhibited an edge failure after 208 hours of testing. Comparable results were also obtained with the 1.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coating system. In this case, one specimen accumulated 446 hours and one 1398 hours (extended testing) without failure, while the third specimen showed a corner failure after 258 hours of cyclic testing.

Exceptional 1500°F oxidation behavior was also noted for the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating system of both coating thickness ratios. Two specimens having a coating thickness ratio of 2.0/0.5 survived the 400 hour cyclic test while the third specimen of this group failed after 66 hours of testing. Specimens with the alternate coating thickness ratio of 1.0/1.5 showed two failures after 310 hours of testing, and one specimen survived the 400 hour test.

At 2400°F, the oxidation performance of the coating systems tested was comparable to those tested at 1500°F. Three of the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> and two of the 1.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coated specimens survived the 400 hour test. One specimen (1.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/1.5 mil VSi<sub>2</sub>) failed at a corner after 258 hours of testing.



250 x

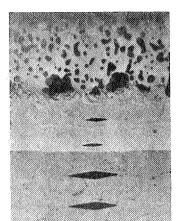
250 x

0.5 mil VSi<sub>2</sub> Barrier Coating

MoSi<sub>2</sub>-20 Ti Si<sub>2</sub>Coating

VSi<sub>2</sub>Coating-I265 kg mm<sup>2</sup>(50gm Load) Diffusion Zone-I5I0 kg/mm<sup>2</sup>(50gm Load)

T-222 Substrate-329 kg/mm<sup>2</sup>(50gm Load)



I.5 mil V Si<sub>2</sub> Barrier Coating

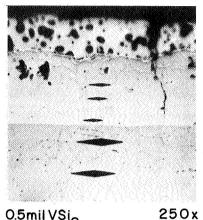
Mo Si<sub>2</sub>-20Ti Si<sub>2</sub> Coating

V Si<sub>2</sub>Coating-I3IOkg/mm<sup>2</sup>(50gm Load)
Diffusion Zone-I5IOkg/mm<sup>2</sup>(50gm Load)

T-222 Substrate - 292 kg/mm<sup>2</sup> (50gm Load)

FIGURE 63

SINTERED AND SILICONIZED MoSi<sub>2</sub> - 20 TiSi<sub>2</sub>/VSi<sub>2</sub> COATED T-222 SPICIMEN



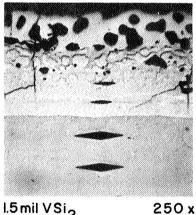
0.5milVSi<sub>2</sub> Barrier Coating

Mo Si<sub>2</sub>-40 Cr Si<sub>2</sub> Coating

 $V Si_2Coating-1310 kg/mm^2 (50 gm Load)$ 

Diffusion Zone-1405 kg/mm<sup>2</sup> (50gm Load)

T-222 Substrate-329 kg/mm<sup>2</sup>(50gm Load)



I.5 mil VSi<sub>2</sub> Barrier Coating

MoSi<sub>2</sub>-40 CrSi<sub>2</sub>Coating

VSi<sub>2</sub>Coating-I2I5kg mm<sup>2</sup>(50gmLoad)

T-222 Substrate - 298 kg/mm<sup>2</sup>(50gm Load)

FIGURE 64

SINTERED AND SILICONIZED MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> COATED T-222 SPECIMEN

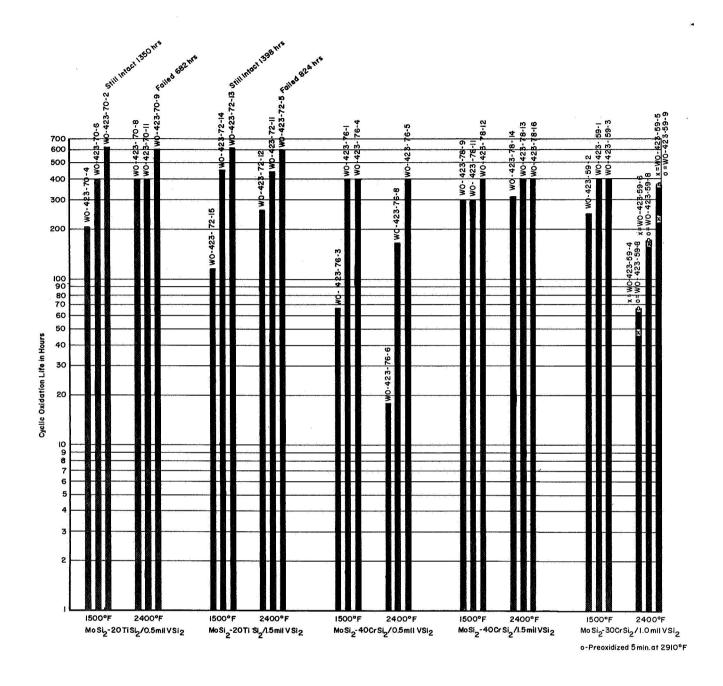
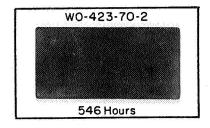
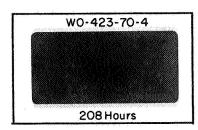
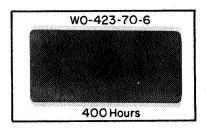


FIGURE 65

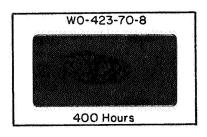
OXIDATION TEST RESULTS OF THE VARIOUS MoSi<sub>2</sub> BASE/ VSi<sub>2</sub> COATINGS ON T-222 AT 1500°F AND 2400°F UNDER CYCLIC CONDITIONS

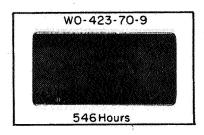






#### 2400°F OXIDIZED TEST SPECIMENS





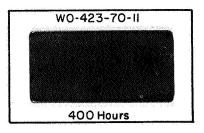
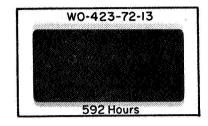
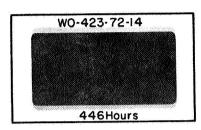
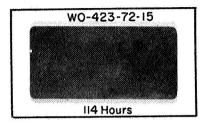


FIGURE 66

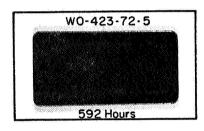
 ${
m MoSi_2}$  - 20  ${
m TiSi_2/0.5}$  mil  ${
m VSi_2}$  COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

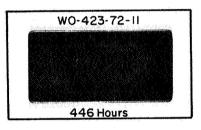






#### 2400°F OXIDIZED TEST SPECIMENS





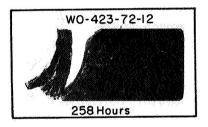
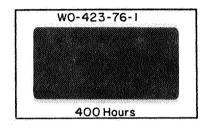
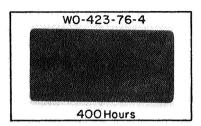
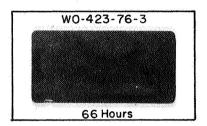


FIGURE 67

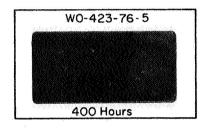
MoSi<sub>2</sub> - 20 TiSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

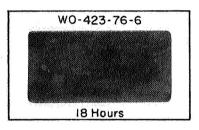






#### 2400°F OXIDIZED TEST SPECIMENS





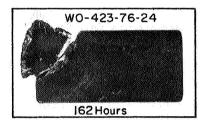
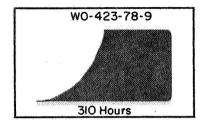
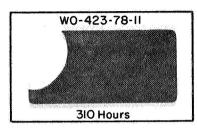
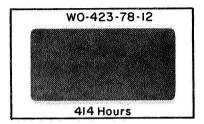


FIGURE 68

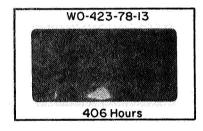
MoSi<sub>2</sub>-40CrSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

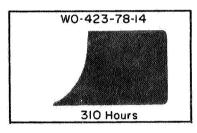






#### 2400°F OXIDIZED TEST SPECIMENS





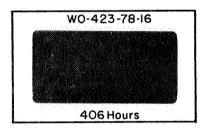


FIGURE 69

MoSi<sub>2</sub>-40CrSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> COATED T-222 SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F AND 1400°F

In extended testing, one specimen of the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> and one of the 1.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> accumulated 824 and 682 hours respectively before failing at a patched site.

The 1.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coating system also showed exceptional oxidation behavior at 2400°F. Two specimens passed the 400 hour test while the third specimen failed after 310 hours of testing. In the case of the 2.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> coating system somewhat shorter oxidation lives (18, 160, and 400 hours) were obtained.

#### 3.3.8 Bend Ductility Tests

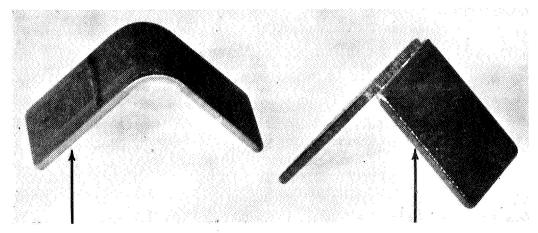
Bend ductility tests (4t) were conducted at room temperature in air on MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> and the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub>-coated T-222 specimens before and after oxidation using a Verson Press Brake. The brake was operated manually in order to control the rate of punch travel at approximately 1.0 inch per minute. All the specimens were bent to a 90° angle. Photographs of the bent specimens are shown in Figures 70 and 71.

Good ductility was shown by specimens of both coating composition before oxidation. However, after being exposed 400 hours at 2400°F in air, the substrate of both coating systems became embrittled indicating oxygen contamination as shown by the photomicrographs of Figures 72 and 73. Oxygen penetration into the T-222 substrate occurred at several sites, however, as indicated, no increase in substrate hardness (280 kg/mm²) was noted.

# 3.3.9 Reliability Tests of the MoSi2-TiSi2/VSi2 and MoSi2-CrSi2/VSi2 Coating Systems

One of the immediate objectives of this program was to improve the high and low temperature reliability of refractory silicide coatings. To test this objective, reliability tests were performed on the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> and the 1.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coating systems on the basis of the previous oxidation test results. Twenty specimens (10 at each test temperature) of the former and 10 specimens (5 at each test temperature) of the latter coating composition were prepared and tested at 1500°F and 2400°F.

In this series of tests the 1.0 mil MoSi<sub>2</sub>-40CrSi<sub>2</sub>/1.5 mil VSi<sub>2</sub> coating combination exhibited a marked improvement in coating reliability. Four of the five specimens tested at each temperature survived 626 hours of cyclic testing without failing. One specimen tested at 1500°F failed at an edge after 532 hours of testing while another exhibited a corner failure after 52 hours of testing at 2400°F.

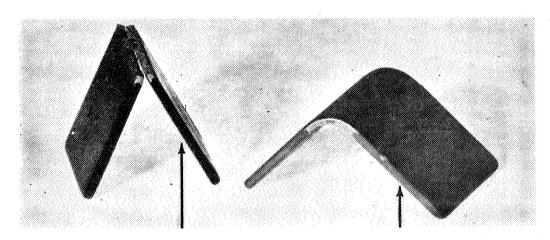


Specimen Not Oxidized

Specimen Oxidized 400 Hours at 2400°F

## FIGURE 70

BEND TEST (4t) MoSi<sub>2</sub>-40CrSi<sub>2</sub>/0.5 MIL VSi<sub>2</sub> COATED T-222 SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F

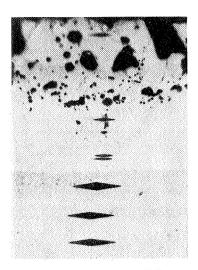


Specimen Oxidized 400 Hours at 2400°F

Specimen Not Oxidized

## FIGURE 71

BEND TEST (4t) MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 MIL VSi<sub>2</sub> COATED T-222 SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F



 $MoSi_2$ -40 Cr  $Si_2$ /VSi\_2Coating 1405 kg/mm $^2$ (50 gm Load)

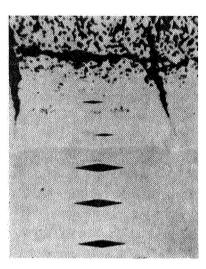
Diffusion Zone-1510 kg/mm<sup>2</sup> (50 gm Load)

T-222 Substrate-259 kg/mm<sup>2</sup> (50gm Load)

250 x

## FIGURE 72

BEND TEST (4t) MoSi<sub>2</sub>-40CrSi<sub>2</sub>/0.5 MIL VSi<sub>2</sub> COATED T-222 SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F



MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub>Coating I3IOkg/mm<sup>2</sup> (50gmLoad)

Diffusion Zone-1405 kg/mm<sup>2</sup> (50 gm Load)

T-222 Substrate-280 kg/mm<sup>2</sup> (50gm Load)

250 x

## FIGURE 73

BEND TEST (4t) MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 MIL VSi<sub>2</sub> COATED T-222 SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F

In the case of the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> coating combination six out of ten specimens failed after 28 hours of testing at 1500°F. Of the four remaining specimens, one failed after 52 hours and two failed after 134 hours. Only one specimen remained intact after 626 hours of testing.

At 2400°F comparably poor results were obtained with the 2.0 mil MoSi<sub>2</sub>-20TiSi<sub>2</sub>/0.5 mil VSi<sub>2</sub> coatings. Six specimens failed after 28 hours, two after 32 hours, one after 52 hours and the remaining one after 534 hours of testing.

In view of this poor performance, a duplicate set of specimens was prepared and, in this case, each specimen was preoxidized at  $2910^{\circ}F$  for 3 minutes in order to initiate some glass (SiO<sub>2</sub>) formation. This treatment, however, had an adverse effect on this coating combination. All ten specimens failed catastrophically after the second 2-hour cycle at  $1500^{\circ}F$ . Slightly improved results were obtained in tests of the preoxidized specimens at  $2400^{\circ}F$ , however, lifetimes were much poorer than those obtained in previous tests of this coating system (Section 3.3.7). The oxidation test results are tabulated in Appendix A (pages A-59 to A-68) and summarized in Figure 74.

At the time these tests were performed, no explanation could be found for the poor oxidation lives shown in the reliability tests compared to the excellent results obtained in initial tests of the MoSi<sub>2</sub>-TiSi<sub>2</sub>/VSi<sub>2</sub> system. A potential cause for suspicion was found in the fact that a new batch of prealloyed MoSi<sub>2</sub>-20TiSi<sub>2</sub> powder had been prepared for the reliability tests. Later, however, it was found that siliconization of the specimens for the reliability tests had been accidentally carried out for 8 hours while the long-lived specimens described in Section 3.3.7 had been siliconized for 16 hours. Although this was undoubtedly the cause of premature failure in the reliability tests, time did not permit the preparation of another set of ten specimens for a new test.

# 3.3.10 Electron Microprobe Analysis

Electron microprobe analysis of five silicide coated T-222 alloy specimens was performed by E. F. Fullam, Inc. to determine the distribution of the coating and substrate elements before and after oxidation testing at 2400°F.

The coated specimens that were submitted for analysis were as follows:

Specimen No.

Description

WO-423-70-5

MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> on T-222 before Oxidation testing

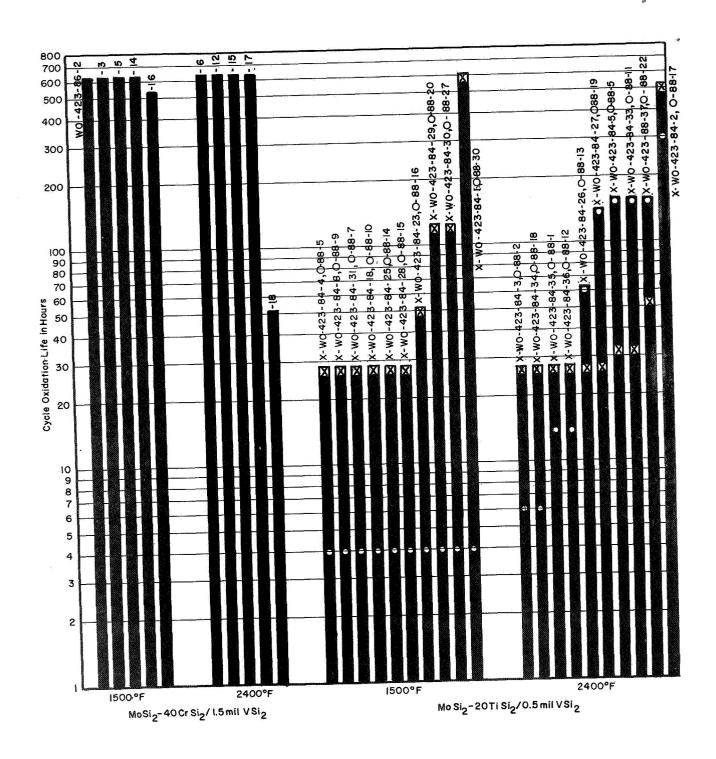


FIGURE 74

CYCLIC OXIDATION TEST RESULTS OF THE MoSi2-20TiSi2/VSi2 AND MoSi2-40CrSi2/VSi2 COATING SYSTEMS AT 1500°F AND 2400°F

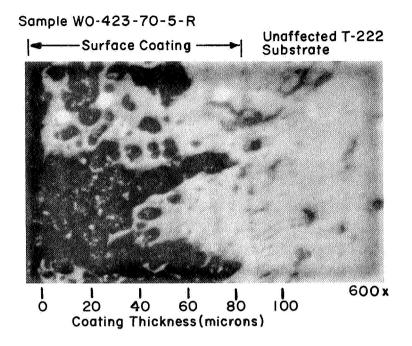
Specimen No.	Description
WO-423-76-11	MoSi2-40CrSi2/VSi2 on T-222 before oxidation testing
WO-423-82-15	33.6MoSi <sub>2</sub> -27.6WSi <sub>2</sub> -19.7TiSi <sub>2</sub> -19.1VSi <sub>2</sub> on T-222 before oxidation testing
WO-423-70-8	MoSi <sub>2</sub> -20TiSi <sub>2</sub> /VSi <sub>2</sub> on T-222 after cyclic oxidation testing for 400 hours at 2400°F
WO-423-76-5	MoSi <sub>2</sub> -40CrSi <sub>2</sub> /VSi <sub>2</sub> on T-222 after cyclic oxidation testing for 400 hours at 2400°F

The specimens were prepared for analysis by cutting small pieces from each, paying particular attention to retain the complete coating. The pieces were mounted in epoxy and polished in a manner to obtain a satisfactory surface without undercutting the coating any more than necessary. After polishing, the mounts were coated with an evaporated carbon film in order to make the plastic mount and the coating conductive. The areas examined were indexed with a scratched line to facilitate indexing of the specimen within the instrument as well as for future reference. An area for analysis was chosen on each side of the specimen.

An accelerating potential of 25 kilovolts and .07 microamperes was used during the analyses. The analyzing crystal was ADP. The specimen was traversed under the beam in a direction normal to the analyzing crystal at a rate of 20 microns per minute.

In each case the traverse was started in the matrix and continued into the coating. The same track was used for each element. In order to establish the concentration level, the X-ray emission intensity of pure molybdenum, vanadium, titanium, chromium and silicon was measured. The elements tantalum and tungsten were not measured since the chemistry of the tantalum alloy was known.

X-ray scanning images were also made for each element of each specimen over the same area as the microprobe traverse. The X-ray scanning images, shown in Figures 77, 78, 81, 82, 85, 86, 89, 90, 93 and 94 consist of many dots which represent characteristic X-rays from a particular area. The lighter areas indicate higher element concentrations than the darker areas. These images show the general distribution of the elements and each area can be compared for the presence or absence of individual elements. To



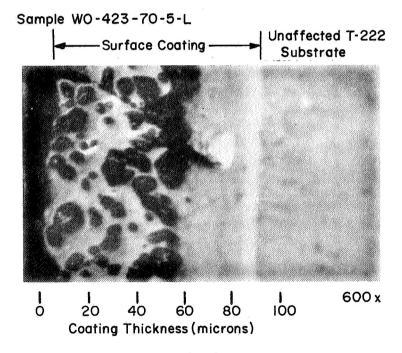


FIGURE 75

PHOTOMICROGRAPH OF MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-70-5)

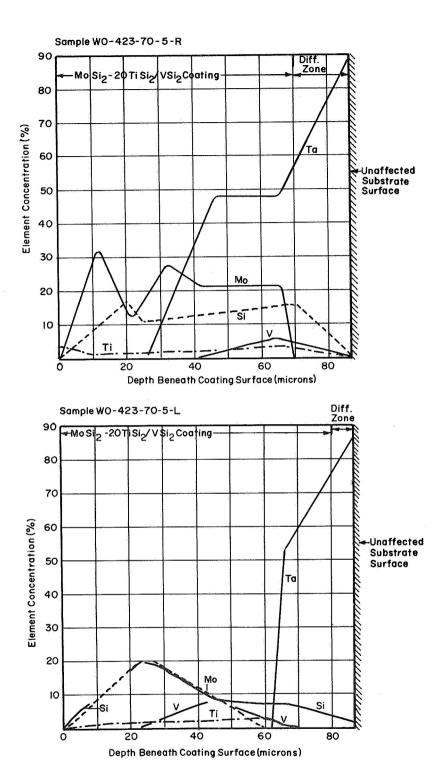


FIGURE 76

MICROPROBE ANALYSIS OF MoSi2-20TiSi2/VSi2 ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-70-5)

Sample WO-423-70-5-R

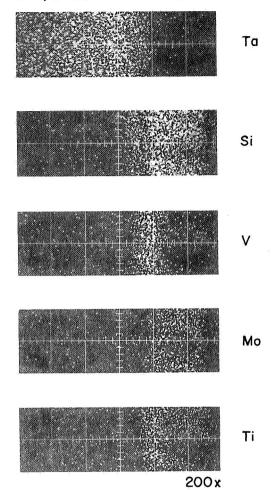


FIGURE 77

SCANNING X-RAY IMAGES OF MoSi2-20TiSi2/VSi2 ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-70-5-R)

Sample WO-423-70-5-L

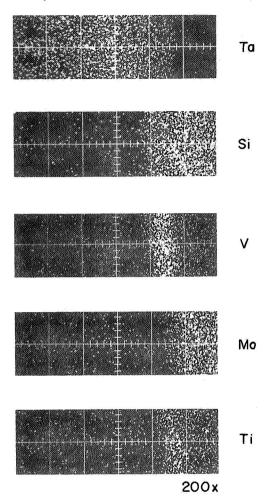
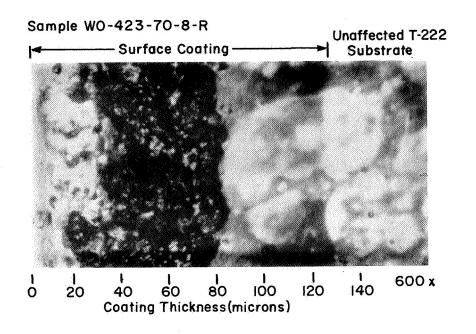


FIGURE 78

SCANNING X-RAY IMAGES OF MoSi2-20TiSi2/VSi2 ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-70-5-L)



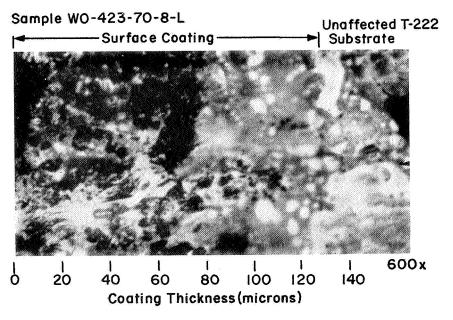


FIGURE 79

PHOTOMICROGRAPH OF MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-70-8)

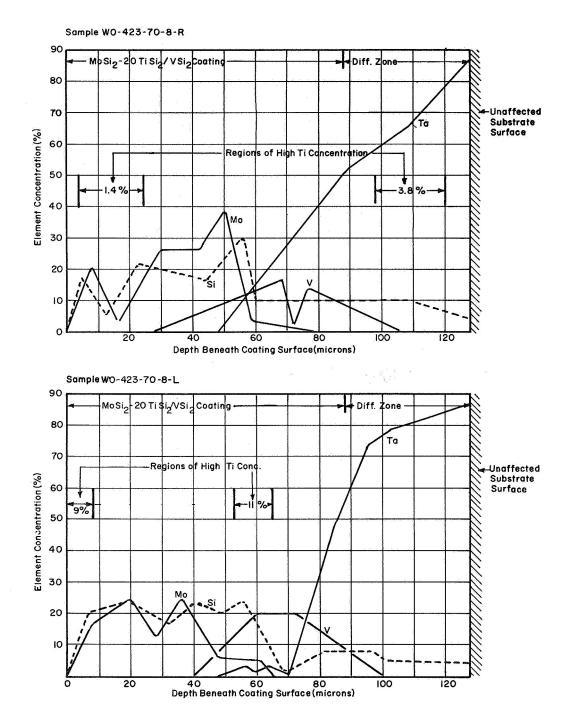


FIGURE 80

MICROPROBE ANALYSIS OF MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-70-8)

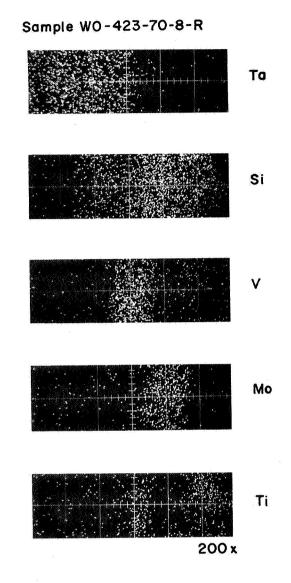


FIGURE 81

SCANNING X-RAY IMAGES OF MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-70-8-R)

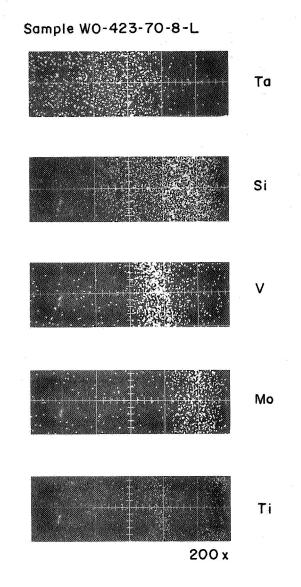
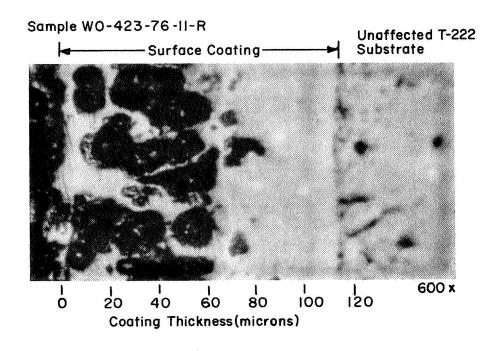


FIGURE 82

SCANNING X-RAY IMAGES OF MoSi2-20TiSi2/VSi2 ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-70-8-L)



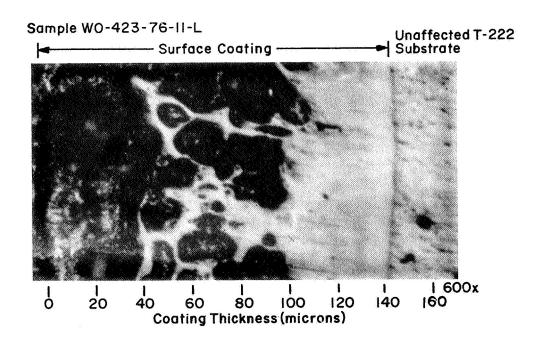
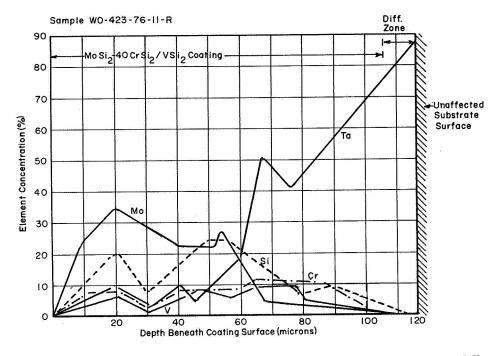


FIGURE 83

PHOTOMICROGRAPH OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-76-11)



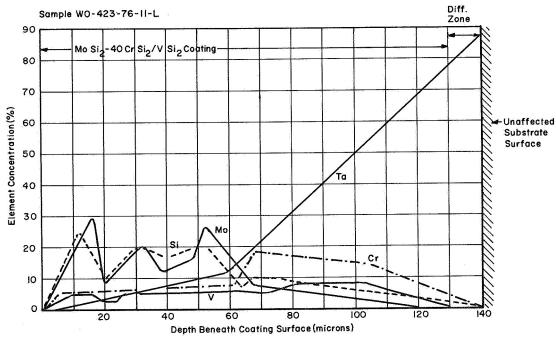


FIGURE 84

MICROPROBE ANALYSIS OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-76-11)

Sample WO-423-76-II-R

Ta

Si

V

Mo

FIGURE 85

200x

SCANNING X-RAY IMAGES OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-76-11-R)

Sample WO-423-76-II-L

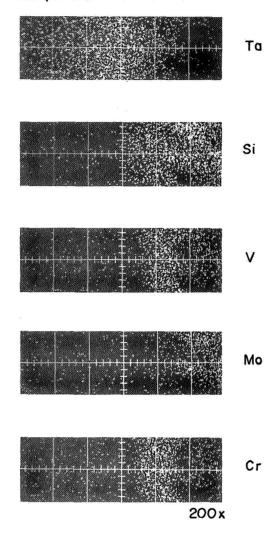
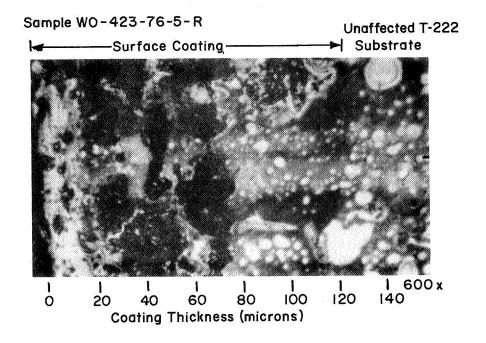


FIGURE 86

SCANNING X-RAY IMAGES OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 BEFORE OXIDATION (SPECIMEN WO-423-76-11-L)



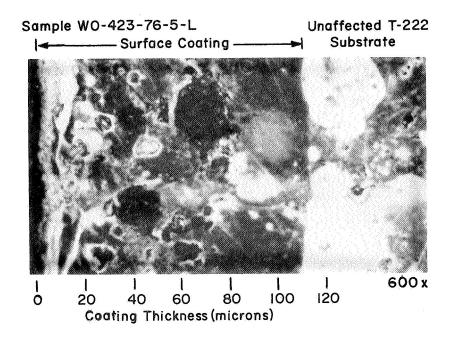


FIGURE 87

PHOTOMICROGRAPH OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-76-5)

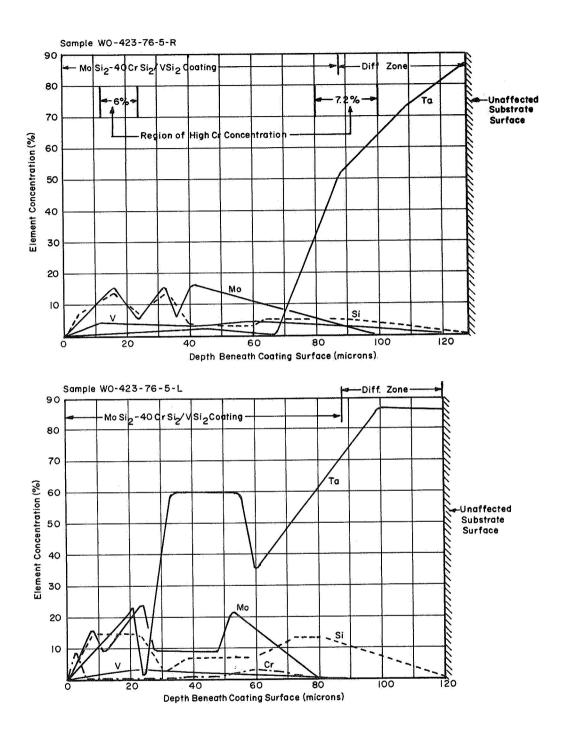


FIGURE 88

MICROPROBE ANALYSIS OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-76-5)

# Sample WO-423-76-5-R

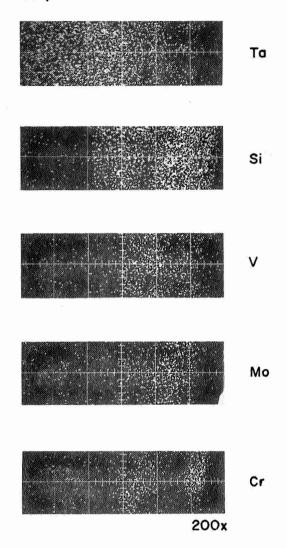


FIGURE 89

SCANNING X-RAY IMAGES OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-76-5-R)

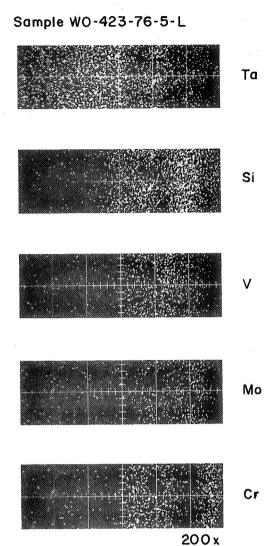
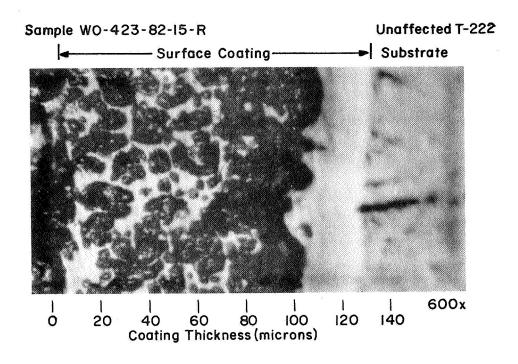


FIGURE 90

SCANNING X-RAY IMAGES OF MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> ON T-222 AFTER 400 HOUR OXIDATION TEST AT 2400°F (SPECIMEN WO-423-76-5-L)



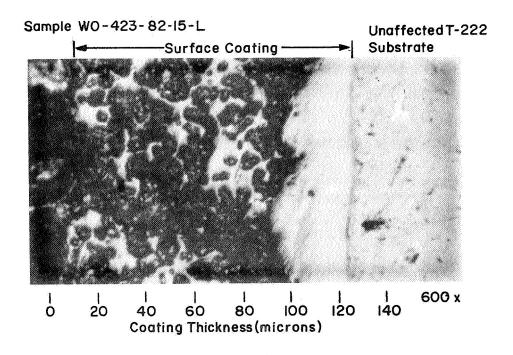


FIGURE 91

PHOTOMICROGRAPH OF 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> ON T-222 (SPECIMEN WO-423-82-15 NOT OXIDIZED)

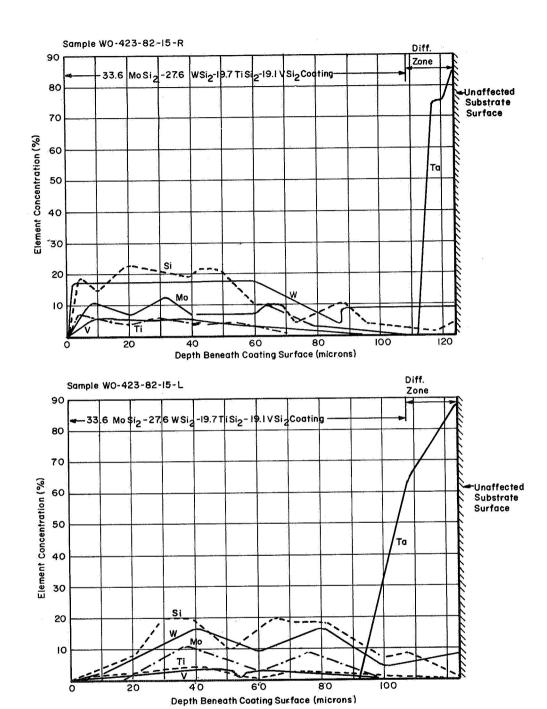


FIGURE 92

MICROPROBE ANALYSIS OF 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> ON T-222 (SPECIMEN WO-423-82-15 NOT OXIDIZED)

# Sample WO-423-82-15-R Ta Si Мо Ti

FIGURE 93

200 x

SCANNING X-RAY IMAGES OF 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> ON T-222 (SPECIMEN WO-423-82-15-R NOT OXIDIZED)

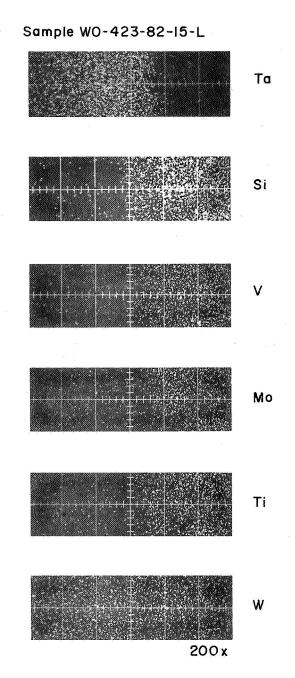


FIGURE 94

SCANNING X-RAY IMAGES OF 33.6 $MoSi_2$ -27.6 $WSi_2$ -19.7 $TiSi_2$ -19.1 $VSi_2$  ON T-222 (SPECIMEN WO-423-82-15-L NOT OXIDIZED)

facilitate this comparison, white grid lines were included in each photograph so that specific regions of the specimens can be compared closely.

Photomicrographs, at 600 magnification, of the two areas analyzed on each specimen are shown in Figures 75, 79, 83, 87, and 91, and charts of element concentration versus depth beneath the coating surface for each specimen are shown in Figures 76, 80, 84, 88, and 92. The concentration profiles shown in the latter figures are smoothed averages of the analytical traces obtained from the original electron microprobe strip chart recordings.

In examining the photomicrographs and concentration profiles of both the oxidized and non-oxidized specimens that were analyzed, some trends in the extent of diffusion of the various coating elements become apparent and can be summarized as follows:

- a) Silicon diffused into the T-222 substrate to a depth of approximately 10 microns after the siliconization treatment (Figures 76, 84, and 92).
- b) A difference in diffusion rate was noted for some of the elements of each coating system on opposite sides of the specimen. For example, in the MoSi2-20TiSi2/VSi2 coating system, one side of the specimen showed that Ti and V diffused to a depth of 15 microns into the T-222 substrate and that tantalum diffused into the coating to a depth of 45 microns. On the opposite side of the specimen no diffusion of Ti and V was observed and only a diffusion depth of 15 microns was noted for tantalum. Similar discrepancies which cannot be explained at this time were observed in the other coating systems (Figures 84 and 92).
- c) In all instances Mo showed no tendency to diffuse into the T-222 substrate (Figures 76, 84, and 92).
- d) In the 400 hour-oxidized specimens of the same coating systems the diffusion zone increased four-fold from 10 microns to approximately 40 microns with silicon being the predominant diffusing specie (Figures 80 and 88).
- e) It was also noted in the oxidized specimens that Ti in the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> system, and Cr in the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating systems both segregated near the surface and near or in the diffusion zone of each specimen. The region of segregation varied from side to side of each specimen as indicated in the concentration profiles (Figures 80 and 88).

- f) In the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating system after oxidation, tantalum was found to have completely diffused through the entire coating, whereas in the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> coating system tantalum diffusion into the coating was inhibited. The outer portion of the coating (approximately 40 microns thick) was found free of tantalum (Figure 88).
- g) In the case of the quarternary MoSi2-WSi2-TiSi2-VSi2 coating system, only silicon diffusion into the substrate was found to have occurred. Approximately a 15 micron-thick region of the T-222 substrate was affected. It was observed, as in the case of the MoSi2-40CrSi2/VSi2 system, that tantalum did not diffuse at equal rates into the coating on both sides of the coated specimens. On one side of the specimen tantalum diffused to a depth of approximately 15 microns while on the opposite side tantalum was not detected (Figure 92).

## 4. CONCLUSIONS

- a) As determined by pellet tests the binary WSi<sub>2</sub>-base silicide systems WSi<sub>2</sub>-CrSi<sub>2</sub>, WSi<sub>2</sub>-VSi<sub>2</sub>, WSi<sub>2</sub>-TiSi<sub>2</sub> are ineffective in providing 1500°F protection to tantalum alloys due to the limited solid solubility of the phases and the consequent "pest" failure of the unmodified WSi<sub>2</sub>. Pest failures were not, however, observed in pellet oxidation tests of the MoSi<sub>2</sub>-CrSi<sub>2</sub>, MoSi<sub>2</sub>-VSi<sub>2</sub> and MoSi<sub>2</sub>-TiSi<sub>2</sub> systems.
- b) Comparison of the three binary silicide systems MoSi2-CrSi2, MoSi2-TiSi2, and MoSi2-VSi2 at concentrations of 10, 20, and 30% of the second phase indicated that the compositions MoSi2-10VSi2, MoSi2-20TiSi2, and MoSi2-30CrSi2 provide the best protection for T-222 alloy at temperatures of 1500°F and 2400°F. The performance of the MoSi2-CrSi2 system at both test temperatures improved with increasing CrSi2 concentration up to the upper limit of 30% CrSi2 investigated.
- c) Oxidation life at 2400°F of the three MoSi<sub>2</sub>-base systems at the optimum concentration levels is generally improved by siliconization of the sintered coatings for periods of 8-16 hours at reduced pressure.
- d) Oxidation resistance of the siliconized binary MoSi<sub>2</sub>-base systems was not improved by preoxidation for periods up to 300 minutes at temperatures of 2700°F and 2900°F.
- e) When the three binary  $MoSi_2$ -base systems were siliconized for 8 hours or more, a glassy surface was formed upon subsequent exposure to oxidation at temperatures of  $2400^{\rm o}F$  and above. A glassy surface was not formed in any of the siliconized specimens upon exposure to oxidation at  $1500^{\rm o}F$ .
- f) Although 30-50% of the specimens tested of the binary, single-layer, MoSi<sub>2</sub>-base, siliconized coating systems provided 100-400 hours life at 1500°F and 2400°F, reliability was considered poor due to the occurrence of defect failures at random coating sites. Reliability of these systems was not improved by depositing the coatings in two layers of identical composition so as to obtain the same overall thickness. Of the nine coating chemistries investigated, MoSi<sub>2</sub>-30CrSi<sub>2</sub> and MoSi<sub>2</sub>-20TiSi<sub>2</sub> yielded the best results.
- g) Miscellaneous binary, ternary, and quaternary single-layer silicide systems including CrSi<sub>2</sub>-20VSi<sub>2</sub>, MoSi<sub>2</sub>-15CrSi<sub>2</sub>-15VSi<sub>2</sub>, siliconized Mo-15.4Ti (metallic coating), 35MoSi<sub>2</sub>-35WSi<sub>2</sub>-15TiSi<sub>2</sub>-15VSi<sub>2</sub>, and 33.6MoSi<sub>2</sub>-27.6 WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> yielded poorer oxidation lives than the MoSi<sub>2</sub>-30CrSi<sub>2</sub> and MoSi<sub>2</sub>-20TiSi<sub>2</sub> systems.

h) The binary systems MoSi<sub>2</sub>-40CrSi<sub>2</sub> and MoSi<sub>2</sub>-20TiSi<sub>2</sub>, when deposited over a barrier layer of VSi<sub>2</sub> to an overall coating thickness of 2.5 mils, were found to afford outstanding oxidation resistance to T-222 alloy.

Specimens of the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> two-layer system survived up to 1398 hours of cyclic testing at 1500°F and up to 824 hours of cyclic testing at 2400°F before failure.

- i) Excellent reproducibility was achieved with the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> two-layer coating system in oxidation tests at 1500°F and 2400°F. Of the five specimens tested at each temperature only one specimen failed prematurely. Four of the five specimens tested at each temperature accumulated 626 hours before the test was terminated. No failures were noted after termination of the test.
- j) Bend tests (4t) indicated a loss of ductility of the T-222 alloy after oxidation testing both the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> and MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating systems for 400 hours at 2400°F. The "ductile life" of these coatings was not determined.
- k) Electron microprobe analyses of the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub>, MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> and 33.6MoSi<sub>2</sub>-27.6WSi<sub>2</sub>-19.7TiSi<sub>2</sub>-19.1VSi<sub>2</sub> coating systems showed similar diffusion results. The predominant diffusing specie into the T-222 substrate both before and after oxidation was silicon. Tantalum diffused from the substrate into the coating to some degree in all systems before oxidation. After oxidation testing tantalum diffused completely through the MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> coating but tantalum diffusion appeared to be inhibited in the MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub> coating system.

## 5. RECOMMENDATIONS

Two coating systems (MoSi<sub>2</sub>-40CrSi<sub>2</sub>/VSi<sub>2</sub> and MoSi<sub>2</sub>-20TiSi<sub>2</sub>/VSi<sub>2</sub>) have been identified with the potential for providing long term oxidation protection for T-222 alloy at temperatures between 1500°F and 2400°F. Before these coatings could be used, however, the ultimate capabilities and limitations of these systems would need to be defined. Studies which were performed for the binary silicide systems without an underlying layer of VSi<sub>2</sub> - but which were not pursued for the double layer system include:

- a) Coating life as a function of binary silicide composition, total coating thickness, and relative layer thickness.
- b) Effect of free silicon content and coating density on system performance, using optimum composition and thickness.
- c) Further investigation of the loss of ductility of the substrate.
- d) Impact resistance of the coating systems as a function of oxidation exposure, composition, and processing conditions.
- e) Oxidation life at intermediate temperatures, low pressures, and under slow-cycling conditions.
- f) Oxidation studies of intentionally defected specimens to determine self-healing capabilities.
- g) Application and tests of the optimized coating systems on prototype engine hardware.
- h) Mechanical property testing of coated tantalum alloy test specimens.

### REFERENCES

- (1) M. H. Ortner and S. J. Klach, "Development of Protective Coatings for Tantalum T-222 Alloy," Report No. NASA CR 54578, December 1966, by Vitro Laboratories under Contract NAS 3-7613.
- (2) G. V. Samsonov and Ya S. Umanskiy, "Hard Compounds of Refractory Metals," NASA TTF-102, Page 331, (June 1962).
- (3) R. T. Wimber and A. R. Stetson, "Development of Coatings for Tantalum Alloy Nozzle Vanes," Report No. NASA CR-54529, (July 1967).

# APPENDIX A

PROCESSING CONDITIONS AND OXIDATION TEST RESULTS FOR SILICIDE COATED T-222 SPECIMENS

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo Siz - 1015iz

	Specimen Number	1-08-864-0M	WO-472-30-1 WO-423-30-2 WO-423-30-3 WO-423-30-10 WO-423-20-1/ WO-423-30-12	Wo-423-30-3	Wo-423-30-10	Wo-423-20-//	Wo-423-30-12
suc	Dispersion Number	2.34-1	2.34-1	2-34-1	2-34-1	2.59-1	2-3A-1
qıtı	Voltage	700	200	200	200	200	200
Con		30	B	30	30	30	200
		30	30	30	30	30	30
ьгч		3.2	3.2	3.2	7.7	2.4	2.4
	Densification Press (tsi)	01	0/	0/	01	10	9
Bu	Temperature (°F)	2910	2910	2910	2910	2910	2910
irət	_	7	R	8	8	8	K
uiS		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
) St	Temperature (°F)	1	ſ	-	1	1	1
ıizic	Time (hours)	1	1	•	١	•	(
icoi	Atmosphere	ı	ŧ	•	1	1	1
TS.		1	1		•	•	ſ
uo	Temperature (°F)	1	1	1	1	- 1	1
itsb	Time (minutes)	ı	.1		•	1	•
ixoə	Atmosphere	J	1	1	ſ	•	•
		)	1	1	1		ı
_	Number of Cycles	,	1	/	(	1	•
	Oxidation Life (hours)	п	8	Ŋ	1	(	
09 I	Type of Failure	EDGE	SURFACE	GENERAL		1	1
		3	NOW GLASSY	NON-GUASSY	3	1	-
1 LE	les	<u> </u>		1	/	-	,
		1	9		7	п	7
00 <del>1</del> ⁄2	Type of Failure	1	1	1	GENERAL	GENERAL	EOSE
		•)	١	١	Mast. for a cov	Mar. foracev	Nov. 614 SSY

# PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MaSiz - 10VSiz

mber    continues (mils)   continues (mils)   continues (mils)   continues (mils)   continues (mils)   continues (mours)   con	200 200 30 15 15 200 2910 2 4 1400W	2-34-1 200 30 4.0 10 20 2 2 2 2 370 4 4 VACUM	2-34-1 200 30 30 4.0 10 2910 2 4 4 2370 4	2-34-1 200 30 30 40 10 2910 2 2 4RGW 2370	300 300 300 300 300 300 300 300 300 300	2-34-1
Williamps  Milliamps  Time (Seconds)  Densification Press (tsi)  Time (hours)  Atmosphere  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Meight Gain (mgs/cm²)  Mumber of Cycles  Number of Failure  Type of Failure	200 30 15- 15- 10 2910 2910 2370 4	200 30 30 4.0 10 22 22 2370 4 14	200 30 4.0 10 22 4Rssav 4	20 30 40 10 290 22 4860N 2370	30 30	30
Milliamps  Time (Seconds)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere	30 15- 15- 10 2910 2 2 4 4 14- 14- 14- 14- 14- 14- 14- 14- 14-	30 4.0 10 22 22 2370 4 14	30 30 4.0 10 2910 2 4 4 4	30 40 10 2910 2 4RGBN 2370	3.2	30
Time (Seconds)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere	2.6 10 2910 2 4 1370 4 VAGUUM	30 4.0 10 22 22 2370 4 14	30 4.0 10 2910 2 4Resav 4	30 40 19 2910 2 4R69N 2370	3.2	
Densification Press (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Atmosphere  Atmosphere  Time (hours)  Atmosphere  Time (minutes)  Time (minutes)  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere  Mought Gain (mgs/cm²)  Atmosphere	2.6 10 2910 2 1860N 2370 4 VACUUM	4.0 10 2910 2 2370 4 14	4.0 2910 2 4 4 2370 4	40 10 2910 2 4R60N 2370	5.2	30
Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Time (hours)  Time (hours)  Time (hours)  Time (hours)  Time (hours)  Atmosphere  Time (minutes)  Time (minutes)  Atmosphere	2910 2 2 4 2370 4 VACUUM	10 2910 2 4 2370 4 VACUUM	2910 2910 4 4RGW 2370 4	10 2910 2 4RGGW 2370	01	5.2
Temperature (°F)  Time (hours)  Atmosphere  Atmosphere  Atmosphere  Atmosphere  Time (hours)  Atmosphere  Time (minutes)  Time (minutes)  Atmosphere	2910 2 ARGON 2370 4 VACUUM	2910 2 ARGON 2370 4 VACUUM	2910 2 ARGAN 2370 4	2910 2 4R60N 2370	2017	0/
Time (hours)  Atmosphere  Time (hours)  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Atm	2 AREON 2370 4 VACUUM	2 ARSON 2370 4 VACUUM	2 ARSON 2370 4	2 ARGON 2370	4310	2910
Atmosphere  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere  At	ARGON 2370 + VACUUM	ARGON 2370 +	ARGON 2370 +	4R60N 2370	7	R
Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Atmosphere  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere  At	2370 + /ACUUM	2370 + VACUUM	2370	2370	ARGON	ARGON
Time (hours)  Atmosphere  Temperature (°F)  Time (minutes)  Atmosphere  Atmosphere  Meight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)	VACUUM	VACUUM	*	,	2370	2370
Meight Gain (mgs/cm²)  Temperature (°F)  Time (minutes)  Atmosphere  Meight Gain (mgs/cm²)  Number of Cycles  Moxidation Life (hours)  Type of Failure	VACUUM	VACUUM		*	¥	¥
Weight Gain (mgs/cm²)  Fromperature (°F)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Dype of Failure			VACUUM	VACUUM	Meuum	VACUUM
Temperature (°F)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Cydation Life (hours)  Type of Failure	2.24	1.12	3.51	3.1	4.43	1.16
Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Cxidation Life (hours)  Type of Failure	•	1	1	ſ		1
Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Cxidation Life (hours)  " Type of Failure	•	1	ı	İ	(	ſ
Weight Gain (mgs/cm²)  Number of Cycles  Cydation Life (hours)  Type of Failure		•	1	1	(	ſ
Number of Cycles  Oxidation Life (hours)  Dype of Failure	-	1	1	-		
Cxidation Life (hours)  Type of Failure	1	/	,	1	1	ı
Type of Failure	2	7	К	ſ		1
	GENERAL	CPENERAL	GENERAL	-	1	1
Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	)	1	1
H Number of Cycles		ı	1	46	`	`
Oxidation Life (hours)	•	1	1	243	٧	Ŋ
	1	1	1	CORNER	SURFACE	GENERAL
A Appearance of Coating Surface	1	١	ı	SUMMIY-GLASSY	NON-GLASSY	NONFOLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masiz-1015iz

81.0	$\overline{\ }$						-					2												r.	187
W6-423-3	2.30-1	200	30	30	3.2	0	2910	4	ARGON	2370	K	Mauun	5.25	1	1	1	1	ſ	1	1	1	70	60H	STAL INTACT	SUGHTLY GU
Wo-423-30-17	2.34-1	200	30	30	3.2	2	2910	Ŋ	ARGON	2370	٨	Menum	6.72	ı	J	1	1	1	1	1	1	70	60H	STUL INTACT	SHGHTLY GLASSY SUGHTLY GLASSY SUGHTLY GLASSY
WO 423.30-7 WO-423-30-8 WO 423.30-9 WO 423.30-16 WO 423-30+7 WO -425-30+8	2-34-1	200	30	30	2.5	9	2910	N	ARGON	2370	7	JACUUM	5.58	1	-	1	1	1	1	1	1	20	409	STILL INTRET	SIGHTLY GLASSY
WO-423-30-9	2-39-1	200	30	30	4.0	0/	2910	7	ARGON	2370	7	VACUUM	9.31	1	1		}	ч	*	CORNER	Nav-GLASSY	1	1		1
Wo-423-30-8	2-34-1	200	30	30	4.0	0/	2910	ĸ	ARGON	2370	7	VACUUM	8.80	1	1	1	1	/	8	EOGE	Nov-GUASSY	1	١	1	1
Wo-423-30-7	2.34-1	200	30	30	4.0	01	29/0	И	ARGON	2370	2	VACUUM	5.32	-	-(	-	1	/	7	EDGE	NOW GLASSY	١	1	1	1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface
	suo	itibi	Con	guit	Pla		Bu	repr	is	Bu	izin	lico	īS	uo	itabi	cox	ď		0.E	09 I			.E.	00₹2	
				SS	ाज क	/WE	⁄AA.	4 S	CE	ояа	ИС	ITA	ဝ၁					SI	OXIDATION TEST RESULTS						

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo.S.z - 2015;

5	Specimen Number	Wo-423-14-1	W6-423-14-2	Wo-423-14-3	WO-423-14-1 WO-423-14-2 WO-423-14-3 WO-423-14-10 WO-423-14-11 WO-423-14-12	Wo-423-14-11	Wo-423-14-12
	Dispersion Number	2.38-3	2-38-3	2.38.3	2.38-3	2-38-3	2.38.3
	Voltage	200	200	200	200	200	200
	Milliamps	30	30	30	30	30	30
	Time (Seconds)	09	09	09	90	0	09
	Coating Thickness (mils)	E. F.	3.4	3.4	5,3	3.6	3.6
	Densification Press (tsi)	6	0/	0/	9	01	01
	Temperature (°F)	2910	2910	2910	2910	29/0	2910
reju	Time (hours)	7	2	8	8	8	Ŋ
	Atmosphere	ARGON	ARGON	ARSON	ARGON	ARGON	ARSON
	Temperature (°F)	1	-	•	1	1	1
izin	Time (hours)	1	-		1	C	1
	Atmosphere		•	1		1	- Alban
	Weight Gain (mgs/cm²)		,	<b>)</b>	1	ı	١
	Temperature (°F)	1	•		1	1	
-	Time (minutes)	ı		•		1	
•	Atmosphere	1	1		•		
	Weight Gain (mgs/cm²)	1	•	•	1	-)	
	Number of Cycles	1	1	,	•	1	•
	Oxidation Life (hours)	7	7	4	1	ı	t
	Type of Failure	GENERAL	GENERAL	GENERAL	1	1	1
	Appearance of Coating Surface	ng Surface Now-GLASSY	NON-GLASSY	NAW-GLASSY	1	1	(
	Number of Cycles		1		-	-	/
	Oxidation Life (hours)	ı	1	1	8	7	7
	Type of Failure	1	1	J	GENERAL	GENERAL	GENERAL
	Appearance of Coating Surface	}	١	t	Now-FIASSY	Man-Grassy	Now. GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 2015iz

WO-423-14-6 WO-423-14-13 WO-423-14-14 WO-423-14-15	2.38-3 2.38-3	200 200	30 30	09 09	3.7 3.7	01 01	2910 2910	2	ARGON ARGON	2370 2370	*	VACUUM VACUUM	4.20 3.20	l	1		1					7	14 2	EDGE EDGE	CHENTY PLASSY SHENTLY PLASSY SLIGHTLY PLASSY
NO-423-14-13 WO-	2.38-3	200	30	09	5.7	Ó	2910	7	ARGON A	2370	*	VACUUM	4.32				•					1	~	CORNER EI	TIGHTIV CLASSY CIGH
Wo-423-14-6 1	2.38-3	200	25	09	3.6	0/	2910	8	ARGON	2370	*	VACUUM	4.67	ı	•		1	/	8	FOOE	NON-GLASSY				
WO-423-14-5	2-38-3	200	30	09	ež.	0/	2910	K	ARSON	2370	*	VACUUM	3.79	ı	1	.1	ı	,	~	EDGE	NOW-GLASSY				
WO-423-14-4 WO-423-14-5	2-38-3	200	30	90	w.	10	2910	8	ARGON	2370	4	VACUUM	4.86	ı	•	1	ı	1	V	EDSE	NON-GLASSY				
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	A without of Continue Single
				guttı	श्राम		-	retu			ızıu		I C		+	xoə.			0.E					00FZ	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 20 VSiz

WO-742-17-10	2-38-3	200	30	8	3.6	0/	2910	и	ARGON	2370	d	0	VACUUM	7.07	1			1	,	1		•	1	8	9/	SURFACE	•
Wo-473-14-17	2-38-3	200	30	90	3.6	01	2910	N	ARGON	2370	0	, d	VACUUM	8.74	1			1	ı	1	1	•	1	75/	30	EDGE	•
WO-423-14-7 WO-423-14-8 WO-423-14-9 WO-423-14-16 WO-423-14-17 WO-723-17-10	2-38-3	200	30	09	2.6	9	2910	8	ARGON	22.00	0/07	d	VACUUM	4.19	,					ı	1	1	5	7	*	SURFACE	, , , , , , , , , , , , , , , , , , , ,
Wo-423-14-9	2.38-3	200	30	09	20.00	0	2010	2	ARGON	10000	4370	Ø	VACUUM	4.22	1	The state of the s	1	•	1	,	8	GENERAL	NOW-GLASSY	1	J	1	
Wo-423-14-8	2.38-3	200	2	2	200	2.5	2000	S S S S S S S S S S S S S S S S S S S	10001	AKOON	2370	8	VACUUM	61.8				1		,	8	EDGE	Nox-GLASSY		1	)	
No-423-14-7	2.38.3	200	1	200	000	5.7	000	2910	7	AKGON	2370	Ø	VACUUM	9.30			1	1	1	,	4	FORE	ing Surface Nov. Classy	Icon - Carrior	-		
Specimen Number	Dienarcion Number	Total Parameter State and	Voitage	Milliamps			Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	A tmoonhere	Weight Cain (mas/cm2)	Weight Gain (ings) cir.	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	The Contraction of the Contracti	غ ا	: 1	Number of Cycles		Type of Failure
S		<u></u>			nitsl			gair	-it.			-	goo.	-	_	_	tsb	ixos	ъч			009				1.00	-
				. —	รษร	ELI	MΑΣ	IAG	SSE	ocı	яа	AC.	IIT	<b>√</b> O⊃	)					S	TIL	ESI	ят	LES	NC	ITA	ID

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz - 30 VSiz

WO-423-16-1 WO-423-16-2 WO-423-16-3 WO-423-16-10 WO-423-16-11 W6-423-16-12	2.34	200	30	120	5.0	30	3000	`	ARGON	1		ı	1	1	J	ı	ſ	1	1	1	1	/	Ŋ	EDGE	Contain Comers Singer Sugar
Wo-423-16-11	2.34	200	8	120	5:0	30	3090	7	ARGON	1	1	•	1	1	1	1	1	1	,	1	)	,	8	EDGE	Sugary/Sugar
Wo-423-16-10	2-34	200	30	120	5.0	30	3090	/	ARGON	1	1	1	1	,	.1	1	-	)	and the second s		,	_	R	EDGE	Great Places
Wo-423-16-3	2-30	200	25	120	5.45	30	3090	/	ARGON	1	,	ſ			-	1	١	/	ч	GENERAL	NON-GLASSY		1	.)	1
WO-423-16-2	2.30	200	25	120	4.9	B	3090	_	ARGON	1	1	1	1	ı	1	1	)	/	х	GENERAL	Now-GLASSY	1	1	1	1
Wo-423-16-1	2-30	200	25	120	5,45	30	3090	/	ARGON	1	1	1			1	-	1	/	8	GENERAL	ng Surface Now-61955y	-	1	.1	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
	suo	itibr	ωO	gait.	ьг		Bu	retr	ıiS	Bu	izju	osil	īS	uo	idati	жоә	ъ		0.E	120			J.	00₹2	_

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MaSiz - 30 VSiz

200 200 200		120 120 120	5.4 5.0 5.0	30 30 30	3090 3090 3090	, , ,	ARGON ARGON ARGON	2370 2370 2370	*	IM VACUUM VACUUM	3 3.01 1.53	1	1	1	1	1	1	1	1	15 2	142 4	EDGE EDGE	VERY GLASSY SLIGHTLY GLASSY VERY GLASSY
200					•	/						1	1	1	1	1	1			15	142	EDGE	VERY GLASSY
	30	120	<i>S:</i> 4	30	3090	`	REGON	70		X	6											1	
					1		A	23	¥	VACUUM	1.08	1	1	1	1	W	89	GENERAL	NOW. GLASSY	1	ı	1	1
200	32	120	5.4	B	3090		ARGON	2370	*	VACUUM	10.30	1	1	1	)	'	8	GENERAL	Nav-GLASSY	1		1	1
200	30	120	5.4	30	3090	/	ARGON	2370	7	VACUUM	46.0	1	-	1	1	8	X	GENERAL	4		1	ı	
Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure			Oxidation I	-	
יקזנז	Cond	guit	Ыs		Зu	irəi	ni2	31	uizit	iooil	IS_	uo	idabi	xoə.	·4				., ,				
	Voltage	Voltage Milliamps	Voltage  O Milliamps  Time (Seconds)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere	Voltage  Voltage  Milliamps  Time (Seconds)  Pasting Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Time (hours)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Time (hours)  Time (hours)  Time (hours)	Voltage  Confine (Seconds)  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Atmosphere  Time (hours)  Time (hours)  Atmosphere  Atmosphere	Voltage         Milliamps         Time (Seconds)         Coating Thickness (mils)         Densification Press (tsi)         Temperature (°F)         Time (hours)         Atmosphere         Time (hours)         Atmosphere         Weight Gain (mgs/cm²)	Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Time (hours)  Atmosphere	Voltage  Voltage  Milliamps  Time (Seconds)  Densification Press (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Time (hours)  Time (hours)  Time (hours)  Time (hours)  Time (mours)  Time (mours)  Time (mours)  Time (mours)  Time (mours)  Time (mours)	Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Meight Gain (mgs/cm²)  Temperature (°F)  Time (hours)  Atmosphere  Meight Gain (mgs/cm²)  Temperature (°F)  Atmosphere  Meight Gain (mgs/cm²)  Temperature (°F)  Atmosphere	Voltage  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Weight Gain (mgs/cm²)  Temperature (°F)  Weight Gain (mgs/cm²)  Temperature (°F)  Weight Gain (mgs/cm²)	Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Weight Gain (mgs/cm²)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere	Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Time (minutes)  Weight Gain (mgs/cm²)  Atmosphere  Meight Gain (mgs/cm²)  Atmosphere   Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Weight Gain (mgs/cm²)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere   Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Temperature (°F)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Temperature (°F)  Time (minutes)  Atmosphere   Voltage  Conting  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Weight Gain (mgs/cm²)  The mosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Atmosp	Voltage  Condition  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Temperature (°F)  Time (hours)  Atmosphere  Atm	Voltage  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Weight Gain (mgs/cm²)  Temperature (°F)  Weight Gain (mgs/cm²)  The (minutes)  Atmosphere  Press (rail)  Atmosphere  Atmosphere  Mumber of Cycles  Number of Cycles  Number of Cycles  Number of Cycles  Appearance of Coating Surface  Appearance of Coating Surface  Appearance of Cycles  Number of Cycles  Number of Cycles  Appearance of Coating Surface  Appearance of Coating Surface  Appearance of Cycles  Number of Cycles			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masiz - 30 VSiz

	Specimen Number	Wo-423-16-7	WO-423-16-7 WO-423-16-8 WO-423-16-9 WO-423-16-16 WO-423-16-17 WO-423-16-18	Wo-+23-16-9	Wo-423-16-16	Wo-423-16-17	WO-423-16
suo.	Dispersion Number	2.30	2.36	2.30	2-34	2-34	2.34
itibn	Voltage	200	200	200	200	200	200
Co	Milliamps	30	30	30	20	30	30
guiti	Time (Seconds)	120	120	120	120	120	120
ыq	Coating Thickness (mils)	5.3	5.3	5.3	5.0	5.0	5.0
	Densification Press (tsi)	30	30	30	30	30	30
Bui	Temperature (°F)	3090	3090	3090	3090	3090	3090
retr	Time (hours)	_	/	/	1		,
īiS	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
au	Temperature (°F)	2370	2370	2370	2370	2370	2370
īz iu	Time (hours)	B	80	00	Ø	Ø	Ø
osif	Atmosphere	VACUUM	VACUUM	Mouum	VACUUM	VACUUM	VACUUM
!S	Weight Gain (mgs/cm²)	3.21	4.65	4.43	5.13	3.91	4.06
uo	Temperature (°F)	1	1	1	•	1	ı
idati	Time (minutes)	1	ĵ	_	e e e e e e e e e e e e e e e e e e e	1	1
хоэ.	Atmosphere	1	1	ſ		I	1
ď	Weight Gain (mgs/cm²)	1	1		1	1	ı
	Number of Cycles	/	1	•	1	1	1
0 .E	Oxidation Life (hours)	7	8	8		J	.1
09 I	Type of Failure	GENERAL	GENERAL	GENERAL	J	1	
	Appearance of Coating Surface	NOW-GLASSY	NOW-GLASSY	NON-GLASSY	-	1	1
	Number of Cycles	1	-	•	17	18	6/
H.C	Oxidation Life (hours)		1	1	146	148	491
0∳7	Type of Failure	1	1	1	EDGE, SURFACE	EDGE, SURFACE EDSE, SURFACE UNDETERMINED	UNDETERM
		1	1	1	VEDY CHACK VEDY CHACKY VEDY CHOKEY	Very Chace	1601/01

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 10 TiSiz

<u> </u>	Specimen Number	No-423-24-1	No-413-14-K	WO-423-24-3	WO-423-74-10	WO-423-24-1 WO-423-24-2 WO-423-24-3 WO-423-24-10 WO-463-24-11 WO+63-47-12	NO+15-17
	Dispersion Number	2-441	2-441	2-441	2-441	2-441	2-441
	Voltage	150	150	150	150	150	150
	Milliamps	35	33.	35	35	35	35
Sui	Time (Seconds)	90	90	90	90	90	96
		3.75	3.75	3.74	3.0	3.0	3.0
		0/	0/	0/	70	0/	0
_		29/0	29/0	2910	2910	2910	2910
ıixə:		2	7	N	Ŋ	Ŋ	8
ini2	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
8	Temperature (°F)	1	1	1		1	1
nizi	Time (hours)	1	1	.(	9	1	1
icon	Atmosphere	1	1	1	1	1	1
TIS	Weight Gain (mgs/cm²)	1	1	1			•
u	Temperature (°F)		1	1	1	1	1
datio	Time (minutes)	1					•
ixos	Atmosphere	1	1		1		1
14	Weight Gain (mgs/cm²)	1	•	1	1	•	•
	Number of Cycles	/	/	/	•		
J.E	Oxidation Life (hours)	2	2	8	1	1	•
)09 I	Type of Failure	GENERAL	GENERAL	GENERAL	1	1	
	Appearance of Coating Surface	NOW-GLASSY	NON-GLASSY	YSSA10-WON	)	1	1
$\perp$	Number of Cycles		1	t	1	,	1
·F	Oxidation Life (hours)	1	J	J	7	8	N
00 <del>1</del> 7	Type of Failure		•	1	GENERAL	GENERAL	GENERAL
? 		1	1	1	NOW-GLASSY	NON-GIASSY	Now-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 10Ti.Siz

	Specimen Number	No-423-24-4	W6 423-24-4 W0-423-24-5 W6-423-24-6 W6-423-24-13 W0-423-24-14 W0-423-24-15	10-423-24-61	40-423-24-13	WO-425-24-14 V	VO-47.5:74-15
	Dispersion Number	2-4A1	2-441	2-441	2-441	2-441	2.441
	Voltage	150	150	150	150	150	150
	Williams	35	25	35-	35	45	45
) ga	Ministrips  Time (Seconds)	60	8	8	90	96	105
ijs[S	Coating Thickness (mils)	3.75	3.7	8.5	3.0	3:0	3:0
I	Densification Press (tsi)	01	9	0/	0	0/	Q
8		2010	2910	29/0	2910	2910	2910
nirə	Temperature ( - )	6	2	7	7	7	7
Juis	Time (nours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	To manufacture (all)	2200	2370	2370	2370	2370	2370
guiz		7	*	*	X	*	8
īuo	Time (nours)	7	Annual.	Mulling	JACUUM	VACUUM	VACUUM
PiŢiS	Atmosphere	VACUUM	איניייייי	72 /	226	1.13	4.17
	Weight Gain (mgs/cm²)	2.77	////	07:7	0/.4		
uo	Temperature (°F)	1	1	•	1	•	
dati	Time (minutes)	1	1	1	-	1	
ixoe	Atmosphere	ı	ſ	-	1	1	1
Pre	Weight Gain (mgs/cm²)		1	1	1	1	1
-	Number of Cycles	8	/	1		1	1
	Oxidation Life (hours)	*	7	7		1	9
0091	Type of Failure	GENERAL	GENERAL	GENERAL	1		,
	Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	100	1	1
	Mimbos of Civiles			1	8	8	/
Æ	Number of Oycles Oxidation Life (hours)	1	1	1	#	*	2
TAC		940	400	1	CORNER	EDGE, SURFACE	GENERAL
	Type of Failure		1	1	CIKHTLY (7/455Y	GIEUTIVEJACSY GIRMIN GLASSY NON-GLASSY	NON-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-107.512

WO-423-24-7 WO-423-24-8 WO-423-24-9 WO-423-24-16 WO-423-24-17 WO-423-24-18	2-441 2-441	150 150	45 45	120 120	3.0 3.0	01 01	29/0 29/0	8	ARGON ARGON	2370 2370	8	VACUUM VACUUM	4.55 9.75		1		•	1		1	1	3 49	6 320	SURFACE EDGE	C. S. C. S. C. S. C. S. V. C. S. V. C. S. C. S. C. S. C. S. C. V. C. V. C. S. C. V. C. S. C. V. C. S. C. V. C. V. C. V. C. S. C. V. C. V. C. V. C. S. C. V. C. V. C. S. C. V. C. V. C. S. C. V. V. C. V. V. V. C. V.
NO-473-574-0A	2-4A1	150	45	/20	3.1	9	29/0	7	ARGON	2370	Ø	VACUUM	4.17	1		1		1	1	1	1	d	9	SURFACE	
Vo-423-24-9 V	2-4A1	150	35	90	3.7	0	2910	2	ARGON	2370	Ø	VACUUM	3.98	ı	1		1	م	9	FOGE	NOW-GLASSY			1	
10-423-24-8 V	2-441	150	35	06	3.7	0/	2910	8	ARGON	2370	00	VACUUM	3.72	1	•	1		W	Ø	GENERAL	NON-GLASSY	1	Į	1	
40-423-24-7 W	2-4A1	150	35	06	e.	0/	2910	8	ARGON	2370	00	Macuum	3.93	I		1		2	9	SURFACE	Nov-GLASSY		1		
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Coating Surface		l a	Type of Failure	
×	Ö	\ \ \ \ \ \	1		हाब ह	1	+	teri F	· ·	+		icoi.		-	itsb H			nZ		005 I		' Z		₽ 00₹	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 2071Siz

23-26-12	4-8/A	150	80	0	3.2	10	2910		ARGON	ı	1	1	ı		,	1	ı	J	ı	1		1	Ŋ	GENERAL	NOW-GLASSY
1 W6-4	*	3	38	90	N		Ñ	Ŋ	A															Se	
Wo-423-26-1	2-48-4	150	35	B	3.5	0/	2910	ч	ARGON	1	,	ı	1	•	ı	1	1	1	1	,	1	/	K	GENERAL	NOW-GLASSY
WO-423-26-3 WO-423-26-10 WO-423-26-11 WO-423-26-12	2-48-4	150	37	50	j, Q	0/	2910	ч	ARGON	١	1			1	1	•			1	1		/	2	GENERAL	NOW. GLASSY
W0423.26.3	2-48-4	150	33	45	5.2	6	2910	К	ARGON	1	1	1	1	1	1	t.	•	1	7	ED6E	NON-GLASSY		١	•	1
	2-48-4	150	35	40	3.0	9	2910	Z	ARGON	ı	•		1	1		1	1	,	7	SURFACE	Now-GLASSY	-	1	1	
Wo-423-26-1 WO-429-26-2	2.48-4	150	38	45	3,5	01	2910	К	ARGON	1	1	1	1	1	1	1	1	,	2	EDGE	NON-GLASSY		1	1	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface
	suo	itibr	Cor	gait.	PIs		gui	retr	īiS	Вu	isin	lico	īS	uo	idati	xoə	ъ		0.E					540C	
				SS	:TEI	∀WE	Я¥с	I SS	CE	ъвс	ИĊ	(TA	တ					SJ	מרט	RES	TSI	ALI	LIOI	IDV.	хо

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 2015Siz

	Specimen Number	WO-423-26-4	WO-423-26-4 WO-423-26-5 WO-423-26-6 WO-423-26-13 WO-423-26-14 WO-423-26-15	WO-423-26-6	WO-423-26-13	WO-423-26-14	WO-423-26-15
- suc	Dispersion Number	2.48-4	2-48-4	2-48-4	2-18-4	2.48-4	2-48-4
,1415	Voltage	150	150	150	150	150	150
	14	12	35	38	35	38	35
/	Time (Seconds)	45	50	50	80	90	8
	ר Coating Thickness (mils)	3.1	3:/	7:5	e,e,	3.0	3.4
эш	Densification Press (tsi)	9	Ø	0/	9	0	0/
AAA   su	Temperature (°F)	2910	2910	2910	29/0	2910	2910
	Time (hours)	7	4	ęy	Y	Ŋ	7
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
1	1	2370	2370	2370	2370	2370	2370
		X	X	¥	¥	7	X
	Atmosphere	VACUUM	VACUUM	Mevum	VACUUM	VACUUM	VACUUM
1117	Weight Gain (mgs/cm²)	3.18	3.21	1.94	1.88	3.42	3.62
	Temperature (°F)	1	- 1	1	ſ	J	
	Time (minutes)	1	1	1	1	1	***
	Atmosphere	(	J	1	1	1	***
-u	ት Weight Gain (mgs/cm²)	)	J	1	1	•	3
S	Number of Cycles	8)	141	/	J	1	1
נתח	Oxidation Life (hours)	49	42	ч	1	(	1
	Type of Failure	SURFACE	EDGE	EDGE	1	1	1
TS	Appearance of Coating Surface		NOW-GLASSY	NOW-GURSSY	J		1
1 1	Number of Cycles	1	1		\	34	31
	(h Oxidation Life (hours)	l	1	1	Ŋ	138	120
	Type of Failure	1		(	EDAE	GENERAL	EDGE
		)	)	1	GIGHTY-PILASSY STANTIY CHASSY STANTY-GLASSY	SI KHTZV-KLESSV	LIBHIZY-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-20Tisiz

WO-47.3 26-16	2-48-4	150	35	80	Ů.	9	2910	Ŋ	ARGON	2370	8	VACUUM	6.23	1	E		1	1	1	1	1	7,2	363	SURFACE	VERY GLASSY
WO-423-26-17	2.48-4	150	35	06	3.1	01	2910	7	ARGON	2370	B	VACUUM	2.45	-	1		3	1	•		1	"	22	SURFACE	KIGHTRY GLASSY SIGHTRY GLASSY VERY GLASSY
NO-423-26-16	2.40-4	150	35	90	5.5	9	29/0	4	ARGON	2370	Ø	SACUUM	6.14	•	4	1	1	1	1		)	R	¥	EDOSE	KINNTRY GLASSY
WO-423-26-7 WO-423-26-8 WO-423-26-9 WO-423-26-16 WO-423-26-17 WO-423-26-18	2.48-4	150	35	90	3.1	9	2910	И	ARGON	2370	Ø	VACUUM	0.08	,		\$	1	77	40	SURFACE	NOW GLASSY		j	ſ	J
NO-423-26-8	2.48-4	150	35	60	3.2	0	2910	7	ARGON	2370	8	VACUUM	89.9	1		1		26	746	EDGE	Now-GLASSY	1	1.	ı	1
WO-423-26-7	7-94-2	150	35	50	3.0	9	2910	Ŋ	ARGON	2370	00	VACUUM	7.00	1	1	1	1	29	1114	SURFACE	NON-GLASSY		1	•	3
	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
	suo	itib	Con	guit	TEI Pla		<u> </u>	ter		<u> </u>	ıizin		·	uo	itsb	ixoə	ъ		4.0			<u> </u>		.ΦΦ.	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-307522

U.	Specimen Number	10-423-28-1	WO-423-28-2	WO-423-28-1 WO-423-28-2 WO-423-28-3 WO-423-26-10 WO-123-28-1	WO-445-45-10	100000	
,		1010	2.46.6	2-46-6	2.46.5	2.46-5	2-46-3
	Dispersion Number	4.46.6	8 1 2	200	200	200	200
	Voltage	200	200	2	30	32	Þ
Con	Milliamps	30	20	30	,	100	2
_	(0.000)	20	30	30	09	00	9 6
	Time (Seconds)	2.0	64	5.3	S. S.	3.1	5.75
	<b>:</b>	2.7		01	0	9	b
	Densification Press (tsi)	9/8	2000	2000	3090	3090	3090
	Temperature (°F)	30%0	2020	2000			`
1191	Time (hours)	,	,		1000	Mosow	ARGON
	Atmosphere	ARGON	ARGON	ARGON	HKOON	Way.	
	Temperature (°F)	1	1	1	(		1
nizi	Time (hours)	ſ			1		1
uoo	Atmosphere	1	1	1		1	(
:T!S	(2000)	;	ı	,	(	1	
	Weight Gain (mgs/cm/)			٤	ı	1	3
uo	Temperature (°F)	,				1	1
itsb	Time (minutes)	1	6			1	1
txoə	Atmosphere		1	(		1	١
Pr		1	1		,		
1	Number of Cycles	1	/		1		1
Ŧ.		7	8	7	1	1	1
009		GENERAL	GENERAL	GENERAL	5		
ĭ		<	NOW-GLASSY	V NOW GLASSY	1	1	1
	Appearance of Coating Juriace		1		,	`	,
	Number of Cycles			-	N	ĸ	N
	Oxidation Life (hours)	1	1	1	20000	FORE	SURFACE
r A C	True of Failure	i			SUKFACE	14.1 (1000)	CountryConce
		1	1	1	Now-GLASSY	NON-COCHEST	ALIMINATURALLY CONTRACT

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Ma Siz - 307.512

WO-423-28-6 WO-423-28-13 WO-423-28-4 WO-423-28-15	2.46.6	200	30	30	7.5	0/	2090	`	ON ARGON	70 2370	*	um Vacuum	7 2.60	1	1		1	1	1		1	<i>e</i> v	8	E SURFACE
16-423	2.46-6	200	20	30	3.7	6	3090	`	ARGON	2370	x	VACUUM	2.67	1	1	1	1	1	•	1	•		• •	EDGE
Wo-423-28-13	9.34.2	200	0	25	4.0	0/	3090	,	ARGON	2370	x	VACUUM	1.48	1	•	1		1	•	•	9	W	8	CORNER
WO-423-28-6	2-46.5	200	52	30	J.	0/	3090	,	ARGON	2370	X	VACUUM	2.56	J		•	•	•	9	SURFACE	NON-GLASSY		-	
WO-423-28-5	2.46.5	200	30	30	3.1	10	3090	`	ARGON	2370	¥	VACUUM	1.41	1	•	1	1	/	7	SURFACE	Now GLASSY	-		.1
Wo-423-28-4 WO-423-28-5	2-46-5	150	32	90	3.1	10	3090	_	ARGON	2370	*	VACUUM	3.35	I	•	1	)	"	36	CIENERAL	NON-GLASSY	1 :		1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure
	suo	itibr	Coz	gait	ьг		But	reta	īS	8u	izin	opili	S	uo	idati	xoə.	ď		J.O	0,9 T			.E	00₽Z

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-307.512

WO-423-28-18	2-46-6	200	50	32	3.7	9	3090	`	ARSON	2370	8	VACUUM	1.83	J	1	1	1	1	1		9	C.	9	EOGE	SUGATELY GLASSY
WO-423-28-17	2-46-6	200	50	30	3.7	0	3030	`	ARGON	2370	Ø	VACUUM	1.04	1	1	1	ı	1	1	1	1	`	ĸ	EDGE	WANTY GLASSY LIBATIY GLASSY SLANTY GLASSY
Wo-423-28-16	2-46-6	200	50	30	3.7	10	3090	1	ARGON	2370	Ø	MEUUM	2.83	1	1		1		1	•	}	*	80	FOGE	DIGNAY GLASSY
Wo-423-28-9	2-46-6	200	50	30	3.7	0/	3090	/	ARGON	2370	Ø	VACUUM	0.91	1	<b>.</b>	1	•	/	4	SURFACE	Now-GLASSY	444.2	1	ı	1
WO-423-28-7 WO-423-28-8 WO-423-28-9 WO-423-28-16 WO-423-28-17 WO-423-28-18	2-46-6	200	50	30	3.7	0/	3090	/	ARGON	2370	B	VACUUM	2.78	•	1	ı	1	/	7	SURFACE	YSSA-GLASSY	,	4	1	l
WO-423-28-7	2-46-6	200	50	30	1.5	9	3090		ARGON	2370	Ø	VACUUM	080	1	ı	1	1	_	N	GENERAL	Now-GLASSY		1	(	1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	g	Type of Failure	Appearance of Coating Surface
	suc	ditio	Con	gui		_	AAA ga	inet			<del></del>	it t.#		uc	dati	ixoə		c		09 I  इज्र भ	LS	H.J. 1		TAŒ	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Ma Siz - 10Cr Siz

WO-423-18-1X	2-54-1	150	-5E	45-	2.9	01	29/0	N	ARGON	1	(	1	1	1	1	1	J	1	•	ſ	1	,	7	GENERAL	NON-19/18 SCY NON-19/1855Y NON-18/1855Y
Wo-423-18-11	2-54-1	150	35	45	3.1	0/	2910	×	ARGON	1			-	1	1	J	•	1	1	1	1	/	8	GENERAL	Now Plassy
NO-423-18-10	2.54-1	150	-5.5	45-	3.0	Ó	29/0	7	ARGON	1	1	1	J	1	ſ	ſ	1	1	5		1	/	7	SURFACE	NON- 19/855V
Wo-423-18-31	2-54-2	150	35	940	3.2	0/	29/0	7	ARGON			1	1	,	1	1		,	8	EOGE	NON- GLASSY	-	ſ	1	ĵ
WO-423-18-1 WO-423-18-2 WO-423-18-3 WO-423-18-10 WO-423-18-11 WO-423-18-1X	2-54-1	150	30	45	6,6	01	29/0	и	ARGON	ı		i	ı	ı	1			1	8	EOSE	NON-GLASSY	1	1	1	)
WO-423-18-1	2-54-1	150	30	45	3.6	0/	29/0	7	ARGON			1	1	1	1	1	1		2	EDGE	1 5	1		1	1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)		Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Coating Surface		Oxidation Life (hours)	Two of Failure	Type of Faithie
	su	oitit	Conc	gui	Plat		Вu	irəi	niS	8	niziı	icoi	ŢŦS	u	otts	охто	Pre	-		09 T	-			00₹	
				S	изл	MEJ	ΑЯ∀	a s	CES	ОЯ	NC I	ĭTA	ဇတ					S	TJU	SES	I JS	LE	NOI	TAG	IIX

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-10CrSiz

0							T										T	T	T	T	1		T	6.	B
WO-423-18-	2-57-2	200	202	30	3.4	Q	2910	Ŋ	ARGON	2370	*	VACUUM	3.10		1	1	1	1	1	1	1	/	8	SURFACE	SUBHTLY GLA
WO-423-18-4 WO-423-18-5 WO-423-18-6 WO-423-18-13 WO-423-18-14 WO-423-18-15	2-54-2	200	30	30	4.5	0/	29/0	8	ARGON	2370	*	VACUUM	3.44	and the second s	1	1	ı	1	1	1	1	,	И	SURFACE	SLIGHTLY GLASSY SLIGHTLY GLASSY SLIGHTLY GLASSY
WO-#13-18-13	2.54-2	200	25-	90	4.9	01	29/0	ч	ARGON	2370	*	VACUUM	5.55	1	1	1	1	1	•	i	1	/	7	SURFACE	SLIGHTLY GLASSY
NO-423-18-6	2-54-2	200	752	09	3.5	0/	29/0	Ŋ	ARGON	2370	X	VACUUM	2.71	1	-	1	1	,	7	EDGE	NON-GLASSY	1	•	1	1
Wo-423-18-5	2-54-2	200	25-	45	4.7	0/	29/0	Ŋ	ARGON	2370	*	VACUUM	5.01	ſ	The state of the s	1	1	52	767	SURFACE	NON-GLASSY	,	ſ	1	,
Wo-423-18-4	2-54-2	200	30	30	5.4	01	2910	8	ARGON	2370	7	VACUUM	6.64		1	•	s	62	390	EDGE	NON-GLASSY	1	1	1	1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	trance of Coating Surface		Oxidation Life (hours)	Type of Failure	Annearance of Coating Surface
		itib	Con		Pla		Вu	1191	niS	81	ıiziı	icoi	īS	uc	itsb	ixoə	I-d		0.E	09 T			·F	007	?
				S	тев	YME	AAA	a s	CEZ	ОЯЗ	N.C.	ITA	ဝ၁					S.	נתח	SI H	TS	1 L E	101	rad	IXO

## PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masiz-10 Cr Siz

8 8 8	2370 2370 2370 2370 23	ARGON ARGON ARGON ARGON ARG	2 2 2 2	WO-423-18-7 WO-423-18-8 WO-423-18-9 WO-423-18-16 WO-423-18-17 WO-423-18-18		25. 25. 25. 25. 25. 25. 25. 25. 25. 25.	25A-2 200 25A-2 200 25 60 25- 10 2910 2370 2370 2370 2370 2370	254-27 2-54-2 200 30 30 30 4,7 0 2910 2 2 4,7 0 2370 8 VACUUM 3,80 - - - - - - - - - - - - - - - - - - -	2.54-2 2.54-2 200 30 30 30 5.4 10 2370 2 48 48cww 1.52 - - - - - - - - - - - - - - - - - - -		Specimen Number  Dispersion Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure
VACUUM   V	8   8   8   8   8       VACUUM   VACU	2370 2370 2370 2370 2370 8 8 8 8 8 8 8 VACUUM VACUUM VACUUM VACUUM 5.43	ARGON       ARGON       ARGON       ARGON       ARGON         2370       2370       2370       2370         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       8       8       8         8       9       8       8         8       9       8       8         8       1.52       2       -         9       1       1       -         1       1       1       -         2       2       2       2         2       2       2       2         3       -       - <td>2.54.2 2.54.2 2.54.2 2.54.2 2.00 200 200 200 200 25 30 30 25 60 30 30 25 60 30 60 60 290 290 290 290 290 290 290 2370</td> <td>, 1</td> <td>~</td> <td>9</td> <td></td> <td></td> <td>1</td> <td></td>	2.54.2 2.54.2 2.54.2 2.54.2 2.00 200 200 200 200 25 30 30 25 60 30 30 25 60 30 60 60 290 290 290 290 290 290 290 2370	, 1	~	9			1	
VACUUM         VACUUM         VACUUM         VACUUM         VACUUM           5.43         7.52         3.80         2.72           -         -         -         -           -         -         -         -           -         -         -         -   -   -   -   -	8         8         8         8           VACUUM         VACUUM         VACUUM         VACUUM           5.43         1.52         3.80         2.72           -         -         -         -           -         -         -         -           -         -         -         -           -         -         -         -           -         -         -         -           -         -         -         -           1         1         1         -           2         2         -         -           EDSE         GENERAL         EDSE         -           1         1         -         -           2         2         -         -           4         2         2         -           5         2         -         -           6         6         6         6           7         -         -         -           8         2         -         -           8         2         -         -           8         2         -         -      <	2370 2370 2370 2370 8 8 8 8 8 8 8 8 68 8  VACUUM VACUUM VACUUM VACUUM 5.43	ARGON         ARGON         ARGON         ARGON         ARGON         ARGON         ARGON         ARGON           2370         2372         2370         2372	2.54.2 2.54.2 2.54.2 2.54.2 2.00 200 200 200 200 200 25 30 30 25 60 30 30 25 60 30 30 25 60 30 30 25 60 30 30 25 60 290 290 290 290 2370 2370 2370 2370 8 8 8 8 8 8 8 8 8 8 5.43 (.52 3.80 2.72		/	C	1	1	1	
VACUUM     VACUUM     VACUUM     VACUUM     VACUUM       5.43     1.52     3.80     2.72       -     -     -     -       -     -     -     -       -     -     -     -       -     -     -     -       1     1     1     -       2     2     2     -       EDGE     GENKERAL     EDGE     -     -	8         8         8         8           VACUUM         VACUUM         VACUUM         VACUUM           5.43         1.52         3.80         2.72           -         -         -         -           -         -         -         -           -         -         -         -           -         -         -         -           -         -         -         -           1         1         1         -           2         2         2         -           2         2         2         -           2         2         2         -           2         2         2         -           2         2         2         -	2370 2370 2370 2370 8 8 8 8 8 8 VACUUM VACUUM VACUUM 5.43 (.52 3.80 2.72 	ARGON     ARGON     ARGON     ARGON     ARGON       2370     2370     2370     2370       8     8     8     8       8     8     8     8       8     8     8     8       8     8     8     8       8     8     8     8       8     8     8     8       9     VACUUM     VACUUM     VACUUM       1.52     3.80     2.72       -     -     -       -     -     -       -     -     -       -     -     -       1     1     -       2     2     -       2     2     -       2     2     -       2     2     -       2     2     -       2     2     -       2     2     -       2     2     -       -     -     -       -     -     -       -     -     -       -     -     -       -     -     -       -     -     -       -     -     -       -     -	2.54.2 2.54.2 2.54.2 2.54.2 2 200 200 200 200 200 200 200 200 200		1	1	NON-GLASSY	NON-GLASSY	Nov- GLASSY	ace
VACUUM     VACUUM     VACUUM       1.52     3.80     2.72       -     -     -       -     -     -       -     -     -       1     1     -       2     2     -	8   8   8	2370 2370 2370 8 8 8 8 8 8 8 /Acuum /Acuum /Acuum /.52 3.80 2.72 	ARGON ARGON ARGON 1370 2370 2370 88 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 25 30 30 25 30 30 25		1	1	EOSE	GENERAL	EDGE	
VACUUM VACUUM VACUUM  1.52 3.80 2.72	8   8   8   8	2370 2370 2370 8 8 8 8 8 8 8 /ACUUM VACUUM VACUUM  1.52 3.80 2.72	ARGON ARGON ARGON 2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72	2.54-2 2.54-2 2.54-2 2 200 200 200 200 30 30 25 30 30 25 30 30 25 30		1	(	7	N	7	1
VACUUM VACUUM VACUUM  1.52 3.80 2.72	8   8   8	2370 2370 2370 8 8 8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72 	ARGON ARGON ARGON 1370 2370 2370 88 8 8 8 8 8	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 257 30 30 257 30 2570 2570 2910 2910 2910 2 2 2 2 2 2 2 2 2 370 2370 2370 2370 2370 2370				,	/	,	1
VACUUM VACUUM VACUUM  1.52 3.80 2.72	8   8   8   8	2370 2370 2370 8 8 8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72 	ARGON ARGON ARGON 2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM 7.52 3.80 2.72	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 25 30 30 25 30 30 25 30 30 25 25 4,7 3.5- 10 10 10 2910 2910 2910 2370 2370 2370 8 8 8 8 8 8 1.52 3.80 2.72	- 1	1	1	1		1	- 1
VACUUM VACUUM VACUUM  1.52 3.80 2.72	8   8   8	2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM 7.52 3.80 2.72	ARGON ARGON ARGON 1370 2370 2370 88 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 25- 30 30 25- 30 30 25- 30 60 25.4 4.7 3.5- 10 10 10 2910 2910 2910 2 2 2 2 2 2 2 2 2370 2970 2970 2370 2370 2370	- 1			1	J	1	
/Acuum VAcuum VAcuum /.52 3.80 2.72	8   8   8	2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72	ARGON         ARGON         ARGON         ARGON           2370         2370         2370           8         8         8           VACUUM         VACUUM         VACUUM           1.52         3.80         2.72           -         -         -	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 25 30 30 25 30 30 60 5.4 4.7 3.5- 10 10 10 2910 2910 2910 2370 2370 2370 8 8 8 8 1.52 3.80 2.72			1	1	1	1	1
VACUUM VACUUM VACUUM 1.52 3.80 2.72	8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72	2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM 1.52 3.80 2.72	ARGON         ARGON         ARGON         ARGON           2370         2370         2370           8         8         8           VACUUM         VACUUM         VACUUM           1.52         3.80         2.72	2.54-2 2.54-2 2.54-2 2 200 200 200 30 30 25 30 30 25 30 30 25 30 4.7 3.5- 10 10 10 2910 2910 2910 2			-	t	-	1	Ĩ
VACUUM VACUUM VACUUM	8 8 8 NACUUM VACUUM	2370 2370 2370 8 8 8 VACUUM VACUUM VACUUM	ARGON         ARGON         ARGON         ARGON         ARGON         ARGON           2370         2370         2370         8         8           8         8         8         8           VACUUM         VACUUM         VACUUM         VACUUM	2.54-2 2.54-2 2.54-2 2 200 200 200 200 30 30 25 30 30 60 5.4 4.7 3.5- 10 10 10 2910 2910 2910 2 2 2 2 2 2 2 2 2370 2370 2370 8 8 8 8		1.50	2.72	3.80	1.52	5.43	1
	8	2370 2370 2370 8 8 8	ARGON ARGON ARGON 2370 2370 8 8 8	2.54-2 2.54-2 2.54-2 200 200 200 200 200 200 200 200 200 2		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	7
2 2 2 ARGON ARGON ARGON	ARGON ARGON ARGON	2 2 2		2.54-2 2.54-2 2.54-2 200 200 200 30 30 25 30 30 60 5.4 4.7 3.5-	T	2910	2910	2910	2910	2910	
2910 2910 2910 2 2 2 ARGON ARGON ARGON .	2910 2910 2910 2 2 2 2 ARGON ARGON	2910 2910 2910	2910 2910 2910	2.54-2 2.54-2 2.54-2 200 200 200 30 30 25 30 30 60 5.4 4.7 3.5	Т	01	0/	0	01	0/	- 7
10 10 10 2910 2910 2910 2 2 2 ARGON ARGON ARGON	10 10 10 2910 2910 2910 2 2 2 ARGON ARGON	10     10     10       2910     2910     2910       2     2     2	10 10 10 2910 2910 2910	2.54-2 2.54-2 2.54-2 200 200 200 30 30 25 30 30 60	T	3.5	-5.5	4.7	5.4	5.5	
5.4 4.7 3.5- 10 10 10 2910 2910 2910 2 2 2 2 ARGON ARGON ARGON .	5.4 4.7 3.5- 10 10 10 2910 2910 2910 2 2 2 2 ARGON ARGON	5.4 4.7 3.5- 10 10 10 2910 2910 2	5.4 4.7 3.5- 10 10 10 2910 2910 2	2.54-2 2.54-2 200 200 200 30 25	T	09	09	30	30	09	. T
30 30 60 5.4 4.7 3.5- 10 10 10 2910 2910 2910 2 2 2 2 ARGON ARGON ARGON .	30 30 60 5.4 4.7 3.5- 10 10 10 2910 2910 2 2 2 ARGON ARGON	30 30 60 5.4 4.7 3.5 10 10 10 2910 2910 2	30 30 60 5.4 4.7 3.5- 10 10 10 2910 2910 2	2.54-2 2.54-2 2.54-2		25	25	30	30	25	
30 30 25 30 30 25 5.4 4.7 3.5 10 10 10 2910 2910 2 2 2 ARGON ARGON ARGON	30 30 25 30 30 60 5.4 4.7 3.5 10 10 10 2910 2910 2 2 2 ARGON ARGON	30 30 25 30 30 25 10 10 10 2910 2910 2	30 30 25 30 30 60 5.4 4.7 3.5 10 10 10 2910 2910 2	2.54-2 2.54-2 2.54-2		200	200	200	200	200	
200     200     200       30     30     25       30     30     60       5.4     4.7     3.5-       10     10     10       2910     2910     2910       2     2     2       ARGON     ARGON     ARGON       2370     2370     2370	200     200     200       30     30     25       30     30     60       5.4     4,7     3.5-       10     10     10       2910     2910     2910       2     2     2       ARGON     ARGON     ARGON	200     200     200       30     30     25       30     30     60       5.4     4.7     3.5-       10     10     10       2910     2910     2       2     2     2	200     200     200       30     30     25       30     30     60       5.4     4,7     3.5-       10     10     10       2910     2910     2910			2.54-2	2.54-2	2-54-2	2.54-2	2.54.2	- 1

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-20Cr.Siz

21-02-524-0	2.58	200	2	150	6.0	30	2910	8	ARGON	1	1	1	1	i		J	1	3	1		•	.1	7	*	£06E	Ven-GLASSY
WO-423-20-1 WO-423-20-2 WO-423-20-3 WO-423-20-10 WO-423-20-11 WO-423-20-12	2.58	200	75	150	6.0	30	2910	8	ARGON	1	•	1	1	1		(	1	1	t			1	7	*	FDGE, CORWER	Now- GIBSSY NOW-GIASSY
WO-423-20-10 W	2.58	200	22	150	0.9	30	2910	8	ARGON	1	•		1			1	•	1		ſ		1	R	4	EDGE, CORNER	
Wo-423-20-3	2-58	200	22	240	5.0	30	2910	8	ARGON	1		1			,	-	1	1	/	7	GENERAL	NON-GLASSY	1	1	1	1
No-423-20-2	2.58	200	75	120	4.7	30	29/0	N	ARGON	1		1	1		1	I	-	1	1	7	GENERAL	Now-GLASSY	1	1	910	
NO-423-20-1	2.58	200	2	150	5.0	30	2910	0	ARGON	1	1		1		1	1	1	1	1	2	GENERAL	Nov-191455Y			1	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)			Time (hours)	Atmosphere	Temperature (°F)		Atmosphere	TITE TO THE CONTRACT COMMENTS	Weight Gain (mgs/cm-)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface Mail 1918 589		Oxidation	Time of Reiling	
					Plat		Яt	ii 19:	haiS	В	uizi	noɔi	TIS		uoț	dat	ixoə	ıα		<u> </u>	0051				00₹	
	suc	oitib							SESS							tsb	ixoə	<u></u> d	S	<u> </u>		ı T2	<b>EL</b> .			_

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 20Cr.Siz

23-20-15	2-58	0,	75	120	47	30	2910	4	ARGON	2370	*	VACUUM	3.28	•		1		1	1	1	1	W	9	EDGE, SURFACE	1514551
14 MO-4	Ż	150	"	"	*	3	2%	.,	4	1/2		7	10									· ·		EDGE	SV NOW.
WO-423-20-1	2.58	200	22	150	5.0	30	2910	7	ARGON	2370	*	VACUUM	3.16		1	1	١	1	1	1	1	6	0/	CORNER	Curimy 21AC
WO-423-20-6 WO-423-20-13 WO-423-20-14 WO-423-20-15	2.58	200	65	150	0.9	30	2910	2	ARGON	2370	4	VACUUM	3.11	t	•	١	١	ŧ			1	9/	90	CORNER SURFACE	Course Change Cherry Black show Class
WO-423-20-6	2.58	150	202	120	4.7	30	2910	N	ARGON	2370	*	VACUUM	2.69	.1	1			20	80	EDGE	NON- GLASSY	1	•	ı	
-	2.58	200	65	240	5.0	30	29/0	И	ARGON	2370	*	VACUUM	2.49	1	1	-	1	36	142	CORNER	NOW-GLASSY	)		ı	
WO-423-20-4 WO-423-20-5	2-58	200	20	042	5.0	30	2910	2	ARGON	2370	*	VACUUM	2.82	1	1	1	1	13	54	EOGE	NOW- GLASSY		1		
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Coating Surface		Oxidation Life (hours)		
				Bui			Bu	itet		8	nizi	icor	<del></del>	uc	datio	ixoə	ъъ		·	09 T				0073	
				s	язт	'ME	AAA	a s	CES	ОЯ	AC I	IITA	တ					S.	LJU	SIY	TS	J.	NOI	ΓAG	IX

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 20 Cr.Siz

-	Specimen Number	Wo-423-20-7	WO-423-20-7 WO-423-20-8 WO-423-20-9 WO-423-20-16 WO-423-20-17 WO-423-20-18	Wo-423.20-9	Wo-423-20-16	WO-423-20-17	WO-423-20-1
suo	Dispersion Number	2.58	2.58	2-58	2-58	2.58	2.58
itibr	Voltage	150	300	200	200	200	200
τοϽ	Milliamps	80	65	22	90	50	20
gait	Time (Seconds)	120	150	150	150	150	150
ьгя	Coating Thickness (mils)	4.7	6.6	5.0	6.0	5.0	5.0
	Densification Press (tsi)	30	30	30	30	30	30
Buj	Temperature (°F)	2910	2910	2910	2910	2910	2910
retr	Time (hours)	7	7	8	7	7	ч
ıiS	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Bu	Temperature (°F)	2370	2370	2370	2370	2370	2370
iisin	Time (hours)	8	8	8	00	0	Ø
lico	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
īS	Weight Gain (mgs/cm²)	3.96	3.28	1.74	21.72	1.96	3.12
uo	Temperature (°F)	1	1	١	1	ı	1
itabi	Time (minutes)	,	1	-	•	\$	ſ
xoə.	Atmosphere	1		1	1	1	1
Δ	Weight Gain (mgs/cm²)	1	•	1	1 :	1	1
_	Number of Cycles	36	20	81	1	1	ı
O.E	Oxidation Life (hours)	142	80	2/2	1	1	
	Type of Failure	CORNER	SURFACE	CORNER	1	1	1
	Appearance of Coating Surface	NON-GLASSY	Now-GLASSY	NOW-GLASSY	1	١	1
	Number of Cycles			1	13	7	15
	Oxidation Life (hours)	1	- 1	1	52	*	26
00 <del>+</del> 2	Type of Failure	1			EDGE	CORNER	SURFACE
	V 2000	1	١	1	NON-GLASSY	Now-GIASSY	May-Glocey

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo Siz - 30Cr. Siz

1434-823	2.50-1	200	45	120	5.4	30	2910	8	ARGON	ı			J	1	,		)	,	1	1	1	37	734	SURFACE	YESHIZY GLASSY
WO-434-78-1 WO-434-80-2 WO-434-82-3	2-50-1	200	45	120	5.4	30	29/0	8	ARGON	1	1		1	1	1	1	1	1	•		1	5	**Z		NON-161ASSY SUBHITY CHASSY
Wo-434-78-1	7-25-7	200	45	120	5.4	30	2910	8	ARGON	J	1	.1	1	1		1	3		1	t	•	W	20	EDGE, SURFACE EDGE, SURFACE	Abu Gracev
WO-434-6-3	7-25-1	200	45	120	5.5	30	2910	8	ARGON			1	1		1	1		5.5	410	STILL INTACT	NON-GLASSY		t	1	1
Wo-434-4-2	7-26-1	200	45	120	5.5	30	2910	7	ARGON	•		1	1	1	1	1	-	5.9	410	STILL INTACT	NON-GLASSY	1	1	ı	-
Wo-434-2-1	2-56-1	200	45	120	5.5	30	2910	~	ARGON			1	1		4	)		59	0/4	STILL INTACT			-		
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface Now-61455)	Number of Cycles	Oxidation Life (hours)	Type of Failure	1
	بنبيه	ditio	Con	gui	Ыs	•	Bu	iret	aiS	81	iizin	osi	ŢS	uc	dati	ixoa	ਾਰ			09 T	-			0073	
		······		S	яэт	ME	AAA	a s	CEZ	ОЯЧ	NC:	ΙΤΑ	ဝ၁					S	ւবն	say	TS	L LE	10I.	ΓAG	IX

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 30C+Siz

434.88-6	2-50-1	200	45	120	5.3	30	2910	8	ARGON	2370	*	VACUUM	1	1	1	J	1	,	1			23	9//	CORNER	W. Ouces
134-86-5 WO	2.50-1 2	200	45	120	5.3	30	2910	*	ARGON	2370	X	VACUUM V	1	1	1	1	1	J	1	1	1	"	50	EDDE (	the Court Comment
WO-434-8-4 WO-434-10-5 WO-434-12-6 WO-434-84-4 WO 434-86-5 WO-434-88-6	2-50-1	200	45	120	5.3	30	2910	7	ARGON A	2370	*	VACUUM	1	1	,	1	1	1	l	1	1	W	20	EDGE	,
Wo-434-12-6	2-50-1	200	45	120	5.5	30	29/0	×	ARGON	2370	X	VACUUM	1	J		-	)	59	01H	STILL INTRET	NON-GLASSY	1	1	ı	
Wo-434-10-5	2-50-1	200	45	120	5.5	30	2910	4	ARGON	2370	*	YACUUM	-	J		ı	1	59	410	STILL INTACT	NON-GLASSY	•	1	i	
4-8-424-0M	2-56-1	200	45	120	5.5	30	2910	~	ARSON	2370	4	VACUUM	1	1	1	1	1	50	014	STILL INTACT		-		1	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
	suo	diti.	Con	-,,		77477	1	r ce		PRO	tizin	<del></del>		uo	itabi	коэ	-4	e i		09 I ९न भ	TS3	L.T. N		.¥π	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mosiz -30Crsiz

_ <u></u>	Specimen Number	1-41-434-0M	Wo-434-16-8	WO-434-14-7 WO-434-16-8 WO-434-18-7 WO-434-90-7 WO-434-92-8 WO-454-544	Wo-434-90-7	NO-434-92-8	NO-454-0N
<u> </u>	Dispersion Number	2-50-1	2-56-1	7-25-1	2.50-1	7-25-7	7-26-1
	Voltage	200	200	200	200	200	200
	Milliamps	45	45	45	45	45	45
	Time (Seconds)	/20	120	120	120	120	120
Plat	Coating Thickness (mils)	5.5	5.5	2.2	5.3	5.3	5.3
	Densification Press (tsi)	30	30	30	30	30	30
	-1	2910	29/0	29/0	2910	2910	29/0
ıi <b>r</b> ə:	Time (hours)	6	~	8	8	2	2
iniS	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Я	Temperature (°F)	2370	2370	2370	2370	2370	2370
luizi		00	Ø	00	ø	Ø	Ø
noəi	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
ĮτS	Weight Gain (mgs/cm²)	)		,	1	1	•
uc	Temperature (°F)	1			1	1	1
datic	Time (minutes)		ı	ı	1	1	1
ixos	Atmosphere	1	ı	1	1		1
υīd	Weight Gain (mgs/cm²)	1	1	1	4	1	1
	Number of Cycles	59	5.9	59	1	1	,
J.	Oxidation Life (hours)	364	014	014	*		1
0091		CORNER	STUL INTACT	STILL INTACT	•	1	
[	Appearance of Coating Surface	1	NON-GLASSY	NOW-GLASSY	1	1	1
	Number of Cycles		)	•	34	*	4
Æ.	Oxidatio	1	1	1	228	42	26
00₺	Type of Failure		1	1	SURFACE, EDGE	EDGE	SURFACE
Z		1	1	1	CHITY CHASSY SUBHILY GLASSY SUBHILY GLASSY	SLIGHTLY GLASSY	SIGHTZY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 10VSiz, DOVBLE CONTED

2.34-1 2-34-1 2-34-1 2-34-1 2-34-1 2-34-1 2-34-1 2-34-1	200		91 91 91 91	2.0 2.3 2.1 2.3 1.9	30 30 30 30	0606 0608 0608 0608		ARGON ARGON ARGON ARGON	2370 2370 2370 2370 2370	8 8 8	VACUUM VACUUM VACUUM VACUUM	3.68 3.63 3.61 2.88 2.79	1	1	1	1		2 2	EDGE	IN-GIASSY NON-GLASSY	0/ / /		~
200 200 100 100 17 16 2.7 2.0	100	3:0	2.0		30	3090	/		2370	В				1		1	\	8	EDSE	SSY NON-GLASSY		1	1
Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm2)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface Now. 62455Y	Number of Cycles	Oxidation Life (hours)	Type of Failure

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Molig-2011, Dauble Contin

Wo-423-27-10 Wo-423-27-20   Wo-423	23-27-30 WO-423.27-40 WO-423.	248-5 248-5 2-48-5	200 200 200	25 20 20	30 30 30	1.7 1.3 1.5-	30 30 30	3090 3000 3090	, , , ,	ARGON ARGON ARGON	2370 2370 2370	8	VACUUM VACUUM VACUUM	115 2.49 1.26	1		1	1	1	20 -	£06£	Now-GUASSY -	7	- + - x	
mils) (tsi) (m2) m2) m3)	NO-423-27-20 WO-4	,							,			0			1		1	1	7	*					
mils) (tsi) m²) m²) m²) ing Surface	WO-423-27-10 V	2.48.5	200	20	30	1.5	25	3090	7	ARGON	2370	8	VACUUM	0.68	1	1	1	1	/	8	SURFACE	NON-GLASSY	1	-	,
Specimen Number Dispersion Number Voltage Milliamps Time (Seconds) Coating Thickness Densification Free Temperature (°F) Time (hours) Atmosphere Temperature (°F) Time (hours) Atmosphere Weight Gain (mgs. Time (minutes) Atmosphere Weight Gain (mgs. Time (minutes) Atmosphere Oxidation Life (hours) Type of Failure Appearance of Con		Dispersion Number	Voltage	Milliamps		Coating Thickness (mils)	Densification Press (tsi)		Time (hours)	Atmosphere		Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Coati	Number of Cycles	Oxidation Life (hours)	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masiz-30CrSiz Dauble Carted

200 200 200	08 06	17 17			3090		ARGON	2370	00	VACUUM	90				_				-				Acco Chantelessy
-		17	3.6	2			-	- 1		3	2.09	)	1	•		1	1	(	1)	,	R	SURFACE	17 17
00.				1	3090		ARGON	2370	0	VACUUM	5.57	1	1		1	1	1	1	3	00	46	CORNER	Comment hour Lines
K	90	17	2.0	30	3090	,	ARGON	2370	8	VACUUM	1.88	1	1	1	1		4	EDGE	NON-GLASSY	1	1	1	!
200	80	17	1.6	30	3090	,	ARGON	2370	Ø	VACUUM	5.72	1	1	1	1	,	×	GENERAL	NON-GLASSY	1	1	1	
200	80	17	1.7	30	3090	/	ARGON	2370	8	VACUUM	1.55	-	1	•	1	62	HOH	STILL INTRET	NOW GLASSY	1		١	
Coltage	voltage Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Coatin	Number of Cycles	Oxidation Life (hours)	Type of Failure	1 1 10 04 1
<u>,                                    </u>		Bur	Plat		Bu	iteti	uiS	<u> </u>	<u> </u>			uo	itsbi	ixoə.						<u></u>			_
Dispersion transcription	000	Voltage         200           Milliamps         80	Voltage  Milliamps  Milliamps  Time (Seconds)	Voltage  Williamps  Williamps  Time (Seconds)  Coating Thickness (mils)  Voltage	Voltage  Milliamps  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)	Voltage   200	Yoltage   200   Milliamps   80	Voltage   200   Milliamps   80   17   17   17   17   17   17   17   1	Voltage   200   Milliamps   80   17   17   17   17   17   17   17   1	Voltage         200           Milliamps         80           Time (Seconds)         17           Coating Thickness (mils)         1, 7           Densification Press (tsi)         30           Temperature (°F)         1           Time (hours)         1           Temperature (°F)         2370           Time (hours)         8	Williamps  Milliamps  Milliamps  Ame (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Temperature (°F)  Time (hours)  Time (hours)  Ameson   Voltage   200   Milliamps   80   17   17   17   17   17   17   17   1	Yoltage	Voltage	Voltage	Voltage	Yoltage	Time (hours)   Voltage	Time (Seconds)  Time (Seconds)  Time (Seconds)  Time (Seconds)  Time (hours)  Time (ho	Weight Gain (mgs/cm²)  Time (minutes)  Time (minutes)  Time (minutes)  Time (minutes)  Time (minutes)  Weight Gain (mgs/cm²)   Voltage  Milliamps  Milliamps  Time (Seconds)  Coating Thickness (mils)  Time (hours)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  A	Weight Gain (mgs/cm²)  Time (hours)  Time (hours)  Time (hours)  Time (hours)  Weight Gain (mgs/cm²)  Time (minutes)  Time (mi			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-10VSiz-TREOXIDIZED

2.34.2 2.34.2 150 165 105 105 2010 200 200 200 200 200 200 20	2.34-22 W 2.34-22 W 2.37-2 105 105 105 105 105 105 105 105 105 105	23-45-2 WO-413-4 50 150 65 20 65 20 65 20 85 20 80 290 80 200 80 200	23-25-3 WO-4 23-25-3 WO-4 20-25-25-25-25-25-25-25-25-25-25-25-25-25-	3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	WO-423-45-1 WO-423-45-2 WO-423-45-3 WO-423-45-4 WO-423-45-5 WO-423-45-6	2.34-2 2.34-2 2.34-2 2.	051 051	20	105	2./	0/	29/0	-	ARGON	2370 2370	8	VACUUM	2.43	2910	8	AIR	3.42	, ,		SURFACE SURFACE, EDGE	Now-GLASSY NOW-GLASSY NOW-GLASSY				
2.34-2 2.34-2 4.0433.45-3 2.34-2 2.34-2 2.34-2 150 150 150 20 35 40 20 35 40 20 25 2.34-2 20 25 2.34-2 20 250 2500 20 20 25 2 20 250 2500 20 200 200 20 200 200 20 200 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200 20 200	2.34-2.3 WO.473-45-4 WO.473-45.5. 2.34-2.2.34-2.2.3-4-2. 2.34-2.2.24-2.2.3-4-2. 2.3-2.2.34-2.2.2-3-2. 2.3-2.2.34-2.2.2-3-2. 2.3-2.2.34-2.2.2-3-2. 2.3-2.2.3-2.2.3-2.2-3-2. 2.3-2.2.3-2.2-3	5-3 WO-473-45-4 WO-473-45. 2 2-3A-2 2-3A-2 2 2-3A-2 2-3A-2 2 2-3A-2 2-3A-2 35 40 130 25 25 40 25 25 20 25 25 20 25 25 20 25 25 20 25	150 473-45-4 W6-473-45-5 150 150 150 150 2-3A-2 150 150 2-3A-2 150 150 2-3A-2		5 WO-423	2.34-2	130	45	120	N.	2	2010	N	ARGON	2370	00	VACUUM	5.46	2910	4	AIR	1.79	1	1	1	-	12	67	E SURFACE	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mosiz-10VSiz-PREDKIDIZED

WO-423-45-8 WO-423-45-9 WO-423-45-10 WO-425-45-11 WO-425-45-12 WO-727-7712	1. 1. 1. 1.	150	20	120	20	0/	2910	2	ARGON	2370	Ø	VACUUM	5.57	2300	15	AIR	2.7%	1	1	1		8	*	E FATCH	7
WO-4-62-45-	2.34.2	150	20	120	c. v.	0/	2910	7	ARGON	2370	Ø	Macuum	3.73	2910	12	AIR	2.23	1	١		1	40	320	SURFACE	1
11-54-574-01	2.34.2	150	35	120	2.0	0/	2910	7	ARGON	2370	8	YACUUM	1.94	2010	15	AIR	2.86	1	1	•	1	8	*	3903	
Wo-423-45-10	2-34-2	150	051	105	8.0	0/	2910	Q	ARGON	2370	8	VACUUM	2:11	2910	15	AIR	1.99	/	7	EDGE	NON-GLASSY	1	l	1	
WO-423-45-9	2-24-2	150	150	105	2.0	0/	2010	2	ARGON	2370	a	VACUUM	5.11	26%	15	AIR	06:1	,	V	SURFACE	NON-GLASSY	1	1	1	
NO-423-45-8	2-34-2	150	145	500	0.0	0	2910	0	ARGON	2370	0	VACIUM	20%	0/06	15	AIR	2.07	/	7	GENERAL		4	1	ı	
Specimen Number	Dispersion Number	Voltage	Williamps	(2000-2)	Time (Seconds)	Danification Dress (tei)	-1	Finiperature ( - )	Time (nours)	Temperature (oF)	remperature ( + )	Time (nours)	Weight Gain (mgs /cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Typearance or comme	Oridation Life (hours)	יאוממוויין איזי יויין יוייין יויין יוייין יוייין יוייין יוייין יויין יוייין יוייין יוייין יויייין יוייין יוייין יוייייין יוייין יוייין יוייייין יויייין יוייין יויייייין יויייין יוי	Type of Failure
-1			puo					_	ıni2		guis	tuoo	itis	u	oits	oxio	Pre		Ŧ.	0091	[		F	.001	7

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz-101Siz-PREOXIDIZED

Wo-423-45-15 Wo-423-45-17   Wo-423	18 WO-423-45-19 WO-4	2.34.2 2.34.2	150 150	40 35	120 120	2.3	0) 01	2910 2910	8	ARGON ARGON	2370 2370	8	VACUUM VACUUM	4.99 4.24	2910 2910	30 30	AIR AIR	3.10 2.86	1	1	1	1	54	392 24	CE CORNER SURFACE
ss (tsi) ss (tsi) /cm²) /cm²) ating Surface	WO-423-45-1	2-34-2	051	35	120	7:7	0/	2910	8	ARGON	2370	B	VACUUM	1.58	2910	30	AIR	2.29		1	t	1	8	*	EDGE, SURFACE
ss (tsi) ss (tsi) /cm²) /cm²) ating Surface	WO-423-45-17	2.34.2	180	35	120	2.0	0/	2910	8	ARGON	2370	80	VACUUM	6.90	2910	30	AIR	2.96	,	N	EDGE	SUMMEN GLASSY	-		1
ss (tsi) ss (tsi) /cm²) /cm²) ating Surface	W6-423-45-16	2-34-2	150	35	120	2.0	9	2910	8	ARGON	2370	Ø	VACUUM	4.52	2910	30	AIR	3.10	/	8	SURFACE	SUGHTLY GLASSY	1	1	1
(mils) (ss (tsi) (cm²) (cm²) (urs) (ss (tsi)	140-423-45-15	2-34.2	150	130	105	2.0	9	2910	ex	ARGON	2370	00	VACUUM	3.68	29/0	200	AIR	2.86	/	7	SURFACE	(LIGHTLY GLASSY	1	1	1
100°F 1500°F Preoxidation Siliconizing Sintering Plating Conditions	Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	18	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	نه ا	Time (hours)	Atmosphere	(mgs/cm	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidatio	Trans of Balline

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz -101Siz - PREGRIDZED

WO-423-45-22 WO-423-45-23 WO-423-45-24 WO-423-45-25 WO-423-45-20	2.34.2	001	40	240	2.0	0/	2910	Q	ARGON	2370	Ø	Macuum	3.94	2730	30	AIR	2.68	-	J	1	1	W	ď	SURFACE, CORNER	UKHRY GLASSY DIGHRY PIASSY LIGHTLY GLASSY
WO-423-45-2	2-34-2	001	04	240	200	01	2910	8	ARGON	2370	Ø	VACUUM	4.18	2730	30	AIR	2.35	1	1	1	ι	50	ø	EDGE	DIEHTZY FILESS
WO-423-45-25	2.34-2	150	40	120	2.2	9	2910	7	ARGON	2370	Ø	VACUUM	10.4	2730	30	AIR	2.4	J	ı	1	1	*	22	EDGE	UKHIZY GLASSY
WO-423-45-24	2-34-2	150	35	120	2.2	0/	2910	8	ARGON	2370	8	VACUUM	1.70	2730	30	AIR	2.2	*	22	SURFACE, ECHES	NOW-GLASSY	1	1	1	ı
WO-423-45-23	2-34-2	150	20	120	2.2	0/	2910	7	ARGON	2370	Ф	VACUUM	4:96	2730	30	AIR	2.2	4	22	SURFACE	NOW-CAPASSY	-	•	,	
Wo-423-45-22	2-34-2	150	20	105	2,2	01	2910	N	ARGON	2370	00	VACUUM	4.46	2730	32	AIR	3.4	#	22	SURFACE	NON-GLASSY	1	1	,	ı
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
_	suo	itib	Con				1	teri	CES	1		licor		uo	itsb	ixoə			O.E ULJ	09 I				00₹2	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz - 2011Siz - TREOXIDIZED

WO-423-46-6	2-418-7	150	20	120	84	Ó	2910	N	ARGON	2370	Ø	VACUUM	4.33	2910	6	AIR	2.56	-	1	ı	1	P	7.4	SURFACE	SHHITY GLASSY
NO-423-46-5	2.48-7	001	9	105	N. K.	9	2910	N	ARGON	2370	80	VACUUM	5.22	2910	بح	AIR	2.15	1	1	1	١	Ø	14	CORNER, EDGE, SURFACE	
NO-423-46-4	2-48-7	100	0/	105	2.2	10	2910	7	ARGON	2370	8	VACUUM	3.45	2910	8	AIR	2.51	1	1	ı	1	22	162	CORNER	SUGHTLY CLASSY
NO-423-46-3	7.48-7	150	12	8	2.2	0	2910	8	ARGON	2370	80	YACUUM	2.50	2910	4	AIR	2.00	13	69	CORNER, SURFACE	SLIGHTLY GLASSY	1			
WO-423-16-1 WO-423-46-2 WO-423-46-3 WO-423-46-4 WO-423-46-5 WO-423-46-6	7-48-7	150	35	8	1.5	9/	2910	4	ARGON	2370	0	VACUUM	4.26	29/0	10	AIR	06:1	×	K	CORNER	SHATTY GLASSY	1	1		-
1-94-824-0M	2-48-7	051	S	06	0.6	9	29/0	6	ARGON	2370	00	VACUUM	2.25	29/0	7	AIR	2.00	N	*	FD6E	GINHILY GUASSY		1	1	
Specimen Number	H	Wolfere	Milliams	(Seconds)	Costing Thickness (mils)	, ,	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs /cm²)	Temperature (*F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface		Number of Cycles	Oxidation Life (nours)	Type of Failure Appearance of Coating Surface
S	-1		puog					_	ani2	_		ruosi	1			bixo			Ŧ.	0051			£	00	₽2
				9	<u>ਦ</u>	MET	(AA)	√d (	SEEC	ов	a oi	NITA	700					s	TTI	າຂອາ	H T	T ES	МО	ITA	OXID

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 2075Siz - Premapizeo

WO-423-468 WO-423-46-9 WO-423-46-10 WO-423-46-11 WO-423-46-12 WO-423-46-13	3.7 2.48.7 2.48.6	00/ 05/ 0	35 10	90 105	2.1 2.1	0/ 0/	0002 0162 0	2 2	ON ARGON ARGON	v 2370 2370	8	UM VACUUM VACUUM	3 4.88 4.72	0/62 0/62 0	15 15	R AIR AIR	5 1.94 2.30		1	1	1	9 +	22 26	ER PATCH FOGE	
110-423	2-48-7	150	35	90	2.1	0/	29/0	C	ARGON	2370	00	VACUUM	4.33	2910	1	AIR	2.15	1	1	1		5	74	CORNER	
WO-423-46-10	2.48.7	150	35	06	2.1	01	29/0	N	ARGON	2370	00	VACUUM	2.40	2910	15	AIR	2.32	K	22	EDGE, SURFACE	SLIGHTLY GLASSY	1	•	1	
10-423-46-9	2-48-7	150	20	96	2.2	9	0/62	7	ARGON	2370	Ø	VACUUM	4.29	0/62	15	AIR	2.12	9/	68	SURFACE	SLIGHTLY GLASSY	J	<b>l</b> 1		
NO-423-468	2-48-7	150	65	105	2.2	0/	29/0	0	ARGON	2370	00	VACUUM	4.77	0/6/	15	AIR	2.61	W	O	EDGE	SUGHTLY GLASSY		1	١	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)				Atmosphere	Temperature (°F)		Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Tune of Bailine	Type of raining
一				gui		—	_	ıtıə:		_	uizi	icon	ŢĪS	u	otts	oxic	ьzа		J.	009 I	:		Æ.	0.0₹	Ż

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSig-ROTSig-PREOXIDIZED

10-425-78-20	2.48-6	150	20	120	2.3	0/	2910	N	ARGON	2370	Ø	Macuum	3.98	0/62	30	AIR	2.92		1	•	1	24	183	SURFACE	SLIGHT CHASSY
WO-425-46-14	2.48.6	001	9	105	2.1	0/	29/0	Ŋ	ARGON	2370	B	VACUUM	4.69	2910	30	AIR	7.24		1	,	1	6	74	CORNER	SLIGHTLY CLASSY SLIGHTLY GLASSY SUGHT CILASSY
NO-423-46-18	2-48-6	001	01	105	7.7	9	2910	7	ARGON	2370	8	VACUUM	2.57	2910	30	A/R	2.88	)	1	1		*	22	CORNER	SLIGHTLY CLASSY
WO-423-46-17	2.48.7	150	30	06	2.1	0/	2910	8	ARGON	2370	00	VACUUM	4.51	2910	30	AIR	2.82	*	22	SURFACE, EDGE	SLIGHTLY GLASSY	- Common	1	ŀ	-
WO 423-46-15 WO 423-46-16 WO 423-46-17 WO 423-46-18 WO 423-46-19 WO 423-46-24	2.40-7	150	35	8	2.1	0/	3910	7	ARGON	2370	Ø	VACUUM	5.33	2910	30	A/R	2.81	*	22	SURFACE, EDGE, CORNER	SUGHTLY GLASSY	0			•
WO-423-46-15	2-46-7	150	20	96	2.0	0	29/0	a	ARGON	2370	8	VACUUM	5.63	2910	30	AIR	2.95	7	*	CORNER	QIGWRY GLASSY				1
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	les	Oxidation Life (hours)		A section of Continue States
		ditio	Con	Sur	Pla		Bu	iret		3	nisi	icon	tis	uc	itsb	txoə	ъч		J.	09 T			.E	00 <del>1</del>	z

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz-20 Tisiz-PREDKIDIZED

NO-415-46-11	2.48-7	150	40	8	2.5	0	2910	8	ARGON	2370	0	VACUUM	5.27	2730	30	AIR	2.33	1	1	1	ì	20	160	CORNER	GIGHTLY GLASSY
WO-423-46-12 WO-423-46-23 WO-423-46-24 WO-423-46-25 WO-425-46-26 WO-427-46-21	2-48-7	150	30	06	2.2	0/	2910	8	ARGON	2370	Ø	VACUUM	5.67	2730	30	AIR	2.28	•	•	1	1	*	22	CORNER	KIGHTLY CKASY
10-473-48-50	2-48-7	150	20	06	2.2	0/	2910	8	ARGON	2370	B	VACUUM	3.7	27.50	30	AIR	2.3	1		1	1	*	22	HATEM	SUGHTLY GLASSY
10-423-46-24 1	2-48-7	150	25	150	8.8	01	2910	8	ARGON	2370	Ø	VACUUM	4.76	2730	30	AIR	2.74	*	22	EDGE	Navioussy	1	.1	ı	•
VO-423-46-23 V	2-40-7	150	25	150	2.2	9	29/0	N	ARGON	2370	Ø	VACUUM	5.82	27.30	2	AIR	1.05	*	22	SURFACE FOOES	Now CEASSY		1		1
WO-423-46-22 W	2-48-7	150	20	06	8.6	01	20/0	7	ARGON	2370	00	VACUUM	5.3/	2730	2	418	0.81	*	22	EDGE	SUGHTY PLASSY	1			
Specimen Number	Dispersion Number	Voltage	Williams	Time (Seconds)		ation Press (t	(°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	4+mosnhere	Weight Gain (mos/cm²)	Temperature (°F)	Time (minute		•	Number of Cycles	Oxidation Life (hours)	Type of Failure	2	les	Oxidation		Type of Faiture
				) Bu	itsl			nita		ROC	nizi				oits	bixo	Pre	1_	o.E	0091		Va 1	·	.00#	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz-30CrSiz-PREOXIDIZED

_	Carriman Mumber	1-14-564-94	ニングルグルング	こってんしゃくかん	WO-443-41-7	26-49-49-1 WO-42-47-2 WO-45-47-5 WO-42-47-4 WO 12-11	
1		0.50-1	2.56-1	7.25.7	7-20-1	2-56-1	2-50-1
tes :	Dispersion Number	1000	150	150	150	150	001
- 1	Voltage	200	2	250	55	55	Z
	Milliamps	200	000	120	120	120	06
	Time (Seconds)	140	00	2.0	1.8	611	2.0
	Coating Thickness (mils)	×.6	3	0/	0	0/	01
	Densification Press (tsi)	900	0,00	2010	29/0	2910	2910
	Temperature (°F)	29/0	200	0	0	8	ч
	Time (hours)	X	Aprox	ARGON	ARGON	ARGON	ARGON
s	Atmosphere	ARGON	AKGO!	0000	01870	2370	2370
	Temperature (°F)	2370	2370	2310	2	d	8
įzi	Time (hours)	00	00	ď	0	3	Incultan
	or o	VACUUM	VACUUM	YACUUM	VACUUM	Menum	VACDUM
	Atmosphere	205	3.81	3.49	4.03	4.19	4.83
1	Weight Gain (mgs/cm²)	2000	2000	2010	29/0	29/0	2910
	Temperature (°F)	7910	7/10	1	1	70	5
	Time (minutes)	2	5	0		AID	AIR
	Atmosphere	AIR	AIR	AIR	XX	VII.	917
	_	601	1.20	1.18	1.23	0.88	0/1/
	Number of Cycles	57	`	/2			1
		09#	~	67		1	1
	Oxidation Directions	C-11 LISTANT	ONTO	CUPEACE	١	1	(
	Type of Failur		shoul Classy	NON-GIASSY	(	1	1
	Appearance of Coating Surface	NON-GLASSI	NOW OKASSI	1000	,	81	8
	Number of Cycles	1				149	24
. 11 .		1			7	74/	20,000
		١	1	1	SURFACE	FATCH	COKNEK
	Type of Failure				NON-GLASSY	NON-GLASSY	NOW-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masig- 30Crsig - PREOXIDIZED

001					2910	N	ARGON	2370	Ø	MACUUM	2.95	2910	2	AIR	1.53	1	•	1	f	*	22	EDGE	NON-GLASSY
	40	105	20	9	2910	4	ARGON	2370	0	VACUUM	3.72	2910	15-	AIR	1.56	1			1	Ø	45	CORNER	NON-GLASSY
100	40	8	2.0	9	2910	ч	ARGON	2370	Ø	VACUUM	2.69	29/0	15	AIR	1.72	1	1		1	9	26	CORNER	Now-GLASSY
001	45	06	1.6	0/	2910	N	ARGON	2370	B	VACUUM	2.63	2910	15	AIR	1.63	12	29	CORNER	NON-GLASSY	ı	.1	1	1
150	50	120	1.2	9	2910	14	ARGON	2370	O	VACUUM	344	2910	75/	AIR	1.21	Ø	45	SURFACE	NON-GLASSY	1	ı	1	1
150	50	120	7.7	9	2910	7	ARGON	2370	00	VACUUM	2.63	29/0	15/	AIR	1.38	30	209	PATCH	NON-GLASSY	1	1	1	1
Voltage	Milliamps	Fime (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	of Coati	Sycles	Oxidation Life (hours)	Type of Failure	A state of Continue State
ــــــــــــــــــــــــــــــــــــــ			<del></del>					8	nizi	nosi	T!S	uc	dati	ixoə	Ιđ								
	Voltage 1/50 1/50 100	Voltage         150         150         100           Milliamps         50         50         45	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage         /50         /50         /90           Williamps         50         50         45           Time (Seconds)         /20         /20         45           Time (Seconds)         2.1         2.2         2.1           Coating Thickness (mils)         2.1         2.2         2.1           Densification Press (tsi)         0         0         0         0           Temperature (°F)         29/0         29/0         29/0         29/0           Time (hours)         2         2         2         2           Atmosphere         ARGON         ARGON         ARGON         ARGON           Atmosphere         8         8         8           Atmosphere         VACUUM         VACUUM         VACUUM         VACUUM           Weight Gain (mgs/cm²)         2.63         3.44         2.63	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masig - 30Cr.Sig Preoxidized

	Specimen Number	W6-423-47.15	Wo-423-47-16	WO-423-47-15 WO-423-47-16 WO-423-47-17 WO-423-47-18 WO-423-47-19 WO-423-47-20	W-423-47-18	WO-423-47-19	Wo-423-472
suo	Dispersion Number	2.50-1	2.50.3	2.56.3	2-56-3	2.56.3	2.56.3
titba	Voltage	150	001	100	001	001	001
ro O	Milliamps	50	2	13-	20	20	20
guțți	Time (Seconds)	120	120	120	120	120	120
ध्य	Coating Thickness (mils)	2.1	ch ch	6.7	2.0	2.0	0.8
,,	Densification Press (tsi)	01	0	10	10	9	01
But	Temperature (°F)	2910	2910	2910	2910	2910	2910
Tetr	Time (hours)	7	7	r	8	ч	И
ıīS	Atmosphere	ARGON	ARGON	ARSON	ARGON	ARGON	ARGON
Su	Temperature (°F)	2370	2370	2370	2370	2370	2370
izin	Time (hours)	00	8	8	8	8	Ø
ooil	Atmosphere	VACUUM	VACUUM	VACUUM	MEDUNA	VACUUM	VACUUM
īS	Weight Gain (mgs/cm²)	2.45	7.38	2.30	1.97	2.37	2.04
üο	Temperature (°F)	2910	0162	2910	2910	2910	2910
idati	Time (minutes)	R	30	30	30	5	R
xoə.	Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR
ъ	Weight Gain (mgs/cm²)	1.42			1.13	1.82	1.82
	Number of Cycles	9/	80	S	•		1
0.E	Oxidation Life (hours)	138	45	45		1	J
051	Type of Failure	EDGES	SURFACE	CORNER, EUGE	1	1	1
	Appearance of Coating Surface	Now-GLASSY	HON-GLASSY	NON-CIRESY	1		1
	Number of Cycles	-			*	4	¥
J.E	Oxidation Life (hours)	metros.			22	24	22
00₽Z	Type of Failure		e confidence	augase .	CORNER	EDGE	CORNER
		ļ	an en		Committee of Some Court	the Course	6

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz-30CrSiz-TREGUIZED

Specimen Number         W0 473 4722 W6 412 4728 W6 412 4728 W6 413 4725 W6           Obspersion Number         2.5C-3         2.5C-3	WO-#25#1-27	2-56-3	001	15	120	2.2	0/	2910	8	ARGON	2370	80	VACUUM	2.82	2730	30	AIR	19.0	1	1	1	•	5	24	CORNER	SIGHTLY GLASSY
Specimen Number  Dispersion Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Cating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	NO-423-47-26	2.50-1	001	45	120	8.0	0/	2910	8	ARGON	2370	8	VACUUM	4.09	2730	30	AIR	1.34	•	9	•	1	9/	138	CORNER	SUGHRY GASSY
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Cating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	40-423-47-25	2-50-3	80/	20	120	0.5	9	29/0	8	ARGON	2370	8	VACUUM	2.81	2730	30	AIR	1.27		1	1	١	/	N	EDAE	Non-GLASSY
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Cating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	NO-423-47-24 V	2.56-3	00/	25	120	21	0/	29/0	8	ARGON	2370	ø	YACUUM	54.1	2730	12	AIR	2.21	/	8	SURFACE	NON-GUASSY	•		1	•
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	WO-423-47-23 W	2-56-3	001	22	130	27	01	20/0	2	ARGON	2370	80	VACUUM	2.81	2730	26	AIR	86:0	25	185	SURFACE	Now-GLHSSY			1	
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Cating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	NO-423-47-22 V	2.56-3	001	00	2 6	140	7:0	0006	-	ARGON	0226	9	VACUUM	1.48	2730	202	418	0.35	1/4	138	Eases	NON-GLASSY	1			1
				v ortage	Milliamps	(Seconds)	#   <b>3</b>	Densincation Fiess (1817)	Time (house)	Time (nours)	, 9		Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Tomperature ( - )	Time (minutes)	Weight Gain (mos/cm²)	Number of Cycles	Oxidation Life (hours)	Tune of Failure	of Coatir				
DATION TEST RESULTS CONTINC PROCESS FARMERING SINGERING PROCESS FARMERING Conditions A400°F Preoxidation Siliconizing Sintering Plating Conditions	Ĺ			<del></del>	<u> </u>			_			-	Buțz	inoo	:II:S	ŭ	otts	bixo	Pre	-							

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz-30C-Siz -TREOXIDIZED

10-465-41-34	255.3	001	0	120	1.5	0	2910	Ŋ	ARGON	2370	9/	MACUUM	5.21	2910	4	AIR	1	1			1	12	69	EOSE	Naw-GLASSY
10-415-41-32	2-56-3	100	25	120	2.1	0	2910	ч	ARGON	2370	9/	VACUUM	6.34	29/0	کم	AIR	1	ı	•	1	3	9/	139	SURFACE	NOW-GLASSY
VO-423-47-52V	2.56.1	001	50	120	2.1	01	2910	6%	ARGON	2370	9/	VACUUM	5.12	29/0	4	AIR	1	,		1	1	*	23	SURFACE	Now. GLASSY
40-423-47-313	2.56-1	100	St.	120	2.7	01	2910	8	ARGON	2370	9/	VACUUM	4.10	2910	P	AIR	1	Ø	46	SUPFACE	NON-GLASSY	1	J	ſ	1
WO-423-47-29 WO-423-47-30 WO-423-47-31 WO-423-47-52 WO-425-47-55 WO-425-47-54	7-56-3	00/	25	120	6:1	91	2910	4	ARGON	2370	19	VACUUM	6.23	29/0	4	AIR	1	*	23	CORNER, EDGE	NOW-GLASSY	1	1	•	1
W-423-47:29 V	2.56.3	100	25	120	2.0	9	2910	4	ARGON	2370	9	VACUUM	402	2010	4	AIR	1	12	164	SURFACE	Now-GLASSY	ı	1	•	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	1	Time (hours)	Atmosphere	Temperature (°F)		Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
المئت			1		Plat		-	iterii		_		rooi	ŢŢS	u	itsb	ixoə	ъъ		J.E	) 20C		L	Æ.	00₺	7

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MOSiz - 30Cr Siz Preoxidized

Al man and	NO-425-4/-4/	2-56-1	150	50	120	7./	ø	2910	N	ARGON	2370	19	Mounn	6.47	2910	7	AIR	1	1	1	ı	-	Ø	48	SURFACE GEMERAL	LIGHTLY GLASSY
1. 100 100 10	WO-423-47-36 WO-423-47-37 WO-423-47-58 WO-423-47-59 WO-423-47-40 WO-425-47-41	2.56-1	150	S	120	2.1	01	2910	7	ARGON	2370	9/	VACUUM	2.29	2910	151	AIR	1	1	1	1	١	X	23	CORNER	QUENTY GLASSY SLEMILY GLASSY
in the second	WO-423-47-39	7.25.2	100	30	120	2.2	Q	2910	N	ARGON	2370	9	VACUUM	5.59	2910	15	AIR	1	1	١	ı	1	9/	139	SURFACE	NON-GLASSY
100	WO-473-41-38	2-50-1	100	30	120	2.1	9	2910	N	ARGON	2370	Ŋ	VACUUM	4.70	2910	15/	AIR	ı	00	46	SURFACE	NON-GLASSY	1	,	(	,
	WO-423-47-37	2-56-1	100	30	120	1.7	9	2910	K	ARGON	2370	16	VACUUM	6.79	2910	15	AIR	1	1	7	CORNER	NON-GLASSY		•	•	1
	Wo-423-47.36	2-56-1	100	30	120	2.0	01	2910	К	ARGON	2370	9/	VACUUM	3.86	2910	15	AIR	1	/	Z	EOSE	NON-GLASSY	1	ı	١	1
	Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface
		suo	itibr	Cor	ez. gait.		าพร	L	ter:			.NG itsin		<del></del> ,	uo	idati	xoə.	ď	Sil	O.E	-	TS	IT V		DA 2400	
					SS	E L	ум Е	ÆΑ	1 SS	CE	ьвс	NC	ÍΤΑ	cc					SI	מרט	ध्य	TS	IL	LIOI	IDV	хo

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo-15-471-81

	1	1	1	1	1	1	1	1	1	•	1	ı	1	ł	1	-	1	1	1	1	1	1	1	1	1
-	•	1	1	,	1	1	1	ı	ţ	1	•	1	1	1	•			.1	3	ı	1	1			ļ
WO 423-48-4	EP.7-8-48-1	150	22	8	2.0	20	3630	W	VACUUM	2370	9/	VACUUM		ŀ	•	<b>4</b> .		19	9/14	STILL INTACT	NON-GLASSY	1	1	-	1
WO-423-48-1 WO-423-48-2 WO-423-48-3 WO-423-48-4	EP-7-8-48-1	150	2	09	2.0	30	3630	W	VACUUM	2370	9/	VACUUM	1		1	1		14	89	SURFACE	NON-GLASSY	1	1	-	
WO-423-48-2	EP-7-8-48-1	150	75	03	2.0	30	3630	E	VACUUM	2370	9/	VACUUM	1:	1		) .	•	17	88	SURFACE	NON-6LASSY	1	-	1	
WO-423-48-1	EP.7-8-48-1	150	52	09	2.0	30	0696	E	VACUUM	2370	9/	VACUUM	P	1	1	J	1	51	<i>0</i> 2	CORNER	NON-GLASSY	J	1	•	
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
	guo	itibr	ωO	guiti	PIS		Zuț	nter	ïS	Bu	izin	osiI	īS	uo	idati	жоә.	ď		0.E	120			J.E	042	_

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: 100-15-471-51

ł	ı	1	1	1	1		1	1	1	[	•	1	1		1	•		1	1	1	.1		1	1	1
Ozon		1	1	1	1	١	,	1		1	}	)		1	1	1	1		1	1					
Wo-423-48-8	EP.7-8-48-1	150	2	90	2.0	30	3630	W	VACUUM	2370	9/	VACUUM	}	1	1	1	<b>,</b>		-	ı	1	8	ħ	SURFACE, EDGE	Now-GLASSY
1-84-87-9M	EP. 7-8-48-1	150	7	09	2:0	30	3630	W	VACUUM	2370	9/	VACUUM	1	ı	l	1	1	ı	1	ı		***	R	SURFACE	Nov-6LASSY
WO-423-48-5 WO-423-48-6 WO-423-48-7 WO-423-48-8	EP.7-8-48-1 EP.7-8-48-1	150	8	09	2.0	29	3630	K	VACUUM	2370	9/	VACUUM	4	-	1	1	1	١		1	4	6/	%	SURFACE	Now-GLASSY
WO-423-48-5	EP-7-8-48-1		28	09	2.0	30	3630	W	VACUUM	2370	9/	VACUUM	,	1		1	1	J			1	ex	7	EDGE	35
Specimen Number	Dispersion Number		Milliamps	Time (Seconds)	Coating Thickness (mils)	1 02	(*F)	Time (hours)	Atmosphere	Temperature (°F)		Atmosphere	Weight Gain (mgs/cm²)	Temmerature (°F)	Time (minutes)	Atmoshipment	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	les	Oxidation Life (hours)	Townson to the second s	Appearance of Coating Surface
S					Plat		_	iiT91			nizi			+-		bixo	•		ਜ•	0051	[		4.	.00 <del>1</del>	7
				S	ਮਤ।	MEJ	AA.	a s	CES	ORG	1C E	IITA	တ					S	TTI	EZI	H TS	TE	NOI	TAC	пхо

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo-15.477-Si

			00/ 00/	01 01: 201 .1.	1102.192.11211	41-84-824-00 51-84-824-00 01-84-8-42 110 110-12-12 W6-12-12 W6-12-14-14	180-423-48-13	41-84-824-0M
	93	Specimen Number	NO-425-45-4	WO-425-48-10	NO-477-1011	840 747 7014	1. 0. 1. 1. 1.	
-	1 .	Dispersion Number	EP.7-8-48-1	1-8-8-13	EP.7.8-48-1	EP.7-8-48-1	EP.78-48-1	EP-7-8-48-1
			150	150	150	150	150	150
	puo	Williams	75	2	80	65	80	75
9		Time (Seconds)	909	09	90	90	90	8
зуз		Costing Thickness (mils)	20	2.1	2.1	2.0	2.0	2.2
MET		- 00	2 2	30	30	30	30	30
iAЯ.			29/0	29/0	2910	29/0	2910	29/0
¥d :		Time (house)	, ~	2	W	W	e/	W
SSE	inis	11me (nours)	VACIUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
ЮЯ		Temperature (°F)	2370	2370	2370	2370	2370	2370
C D			1/2	9/	9/	9/	9/	9/
NIT	coni	Time (mon)	Machines	Menum	VACUUNI	VACUUM	VACUUM	VACUUM
AOS	iţiS		11.03	1101	6.87	13.59	1884	12.94
)		Weight Gain (mgs/cm²)	11.83	21:0/	3			1
	uo	Temperature (°F)	1	1	]	1	<b>J</b>	
	dati	Time (minutes)		1	1	1	1	
	ixos	Atmosphere	l	1	ı	•	1	
	ът	Weight Gain (mgs/cm²)	١	-)	1		j	1
s		Number of Cycles	#	,	*	1	1	
TTL	<b>.</b>	Oxidation Life (hours)	23	7	23	1	1	1
isa:	009	Tune of Failure	SURFACE	SURFACE	SURFACE	1	1	1
A T	τ	Annearance of Coating Surface	NON-FILASSY	Non-GLASSY	Naw-64.455Y	1	١	1
LES		Arthur and Carlos			1	8	K	N
МО	Æ		1		1	•	X	X
ITA	.00	Oxidation Line (non	1	1		EDGE	EDUE	EDGE
XID	ÞΖ	Type of Failur		1	1	Now-GLASSY	NOW-GLASSY	Now-GLASSY
0		Appearance of Coating Surface					+	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Cr.S.z - 20 VSiz

WO-473-51-6	EP-423-51-A	011	25	90	1.7	01	2730	,	ARGON	2370	Ø	VACUUM	2.89	1	١	•			•	•	4	1	Ø	94	EDGE	Nav-GLASSY
Wo-423-51-5	EP-423-51-A	0//	25	09	2.2	0/	2730	,	ARGON	2370	Ø	VACUUM	2.78	1	1	1			1	1	1	1	77	69	CORNER	Now-GLASSY
NO-423-51-4	EP-423-51-A	110	25	90	6.1	0/	2730	1	ARGON	2370	0	VACUUM	691	1		(			,	1	1	1	9/	041	FATCH	Now-GLASSY
WO-423-51-3 WO-423-51-4 WO-423-51-5	EP-423-51-A	011	23-	90	81	0/	2730	/	ARGON	2370	Ø	VACUUM	2.70	1	ı	į.		3	57	766	STILL INTACT	Now-GLASSY	1		1	*
WO-423-51-1 WO-423-51-2	EP-423-51-A	0//	25	90	9.7	9	2730	,	ARGON	2370	ď	NACUUM	2,35	1		•		-	8	9#	EDGE	Now-GLASSY		1	1	
Wo-423-51-1	EP-423-51-A EP-423-51-A	0//	25	09	1.7	0/	2730	,	ARGON	9370	Ch.	MULTINA	7.19				1	1	7/2	69	EDGE	3		J	1	1
Specimen Number	Dispersion Number	Voltage	Williams	Time (Seconds)	Coating Thickness (mils)	ation Press (	٠ ١	Time (hours)	Atmosphere	Temperature (°F)		Time (non-s)	weight Gain (mas /cm²)	Weight Cam (mgs) cm. (	remperature ( r.)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface		Number of Cycles	TIOUT.	Type of Failure
S					Plati		_	itrə:		_		tnoo		_		ptxo					0051				.001	
			<u> </u>	9	EE	WEJ	AЯ	- A	SESS	POS	a D	NIT.	¥O⊃						s	TJU	SES	I LS	TES	NO	ITA	ПХ

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: Masiz - 15 Cr. Siz - 15 V. Siz

Voltage  Milliamps  Milliamps  Time (Seconds)  Coating Thickness (mils)  Temperature (°F)  Time (hours)  Atmosphere	Wo-425-58-1 125- 125- 25- 60- 20- 10- 290- 200- 200- 200- 200- 200- 200- 200- 200- 200- 200- 200- 200- 200- 200	Wo-473-55-2     Wo-473-58-3       Wo-473-584     Wo-473-584       125     125       25     25       60     75       10     10       290     290       2     2       4R6W     4R6W	WO-423-58-3 WO-423-58-4 125- 25- 75- 75- 10 2910 2 4RGW	WO 423-58-4 WO -423-58-5 WO -423-58-4 WO -423-58-5 125 25 60 60 20 20 200 29/0 29/0 29/0 2 2 ARGON ARGON		WO-423-584 WO-423-584 125 25 75 70 10 2910 2 ARGON
Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Temperature (°F)  Time (minutes)	2370 8 VACUUM 2.11	2370 8 VACUUM 3.52 -	2370 8 VACUUM 3.64	2370 B VACUUM 2.04	2370 8 VACUUM 3.64	2370 8 Macuum 3.50
Atmosphere Weight Gain (mgs/cm²)		1 1	1 1	1 1	1	1
Number of Cycles Oxidation Life (hours)	6 94	95/	11	g 1	1	1
e Goating Surface	SURFACE, EDGE NON-GLASSY	CORNER NOW-CHASSY	EDGE NON-GLASSY	1	1	] ]
Number of Cycles Oxidation Life (hours)	1 1	•	) I	15-	119	94
Type of Failure Appearance of Coating Surface		4	1 1	SURFACE SUBITLY-GLASSY		SURFACE EDGE KIGHTYGLASSY SUGHTYGLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: 35Mosiz-35Wsig-15TRsiz-15Vsiz

NO-423-74-12	EP-423-66	200	20	300	5.5	9	2910	1	ARGON	2370	O	VACUUM	4.76	1	•	1	ı	1		1		8	7	EDGE	NOW-62.455Y
NO-423-74-11	EP-423-66	200	99	240	5.0	0/	2910	,	ARGON	2370	Ø	VACUUM	2.75	)	1		1	ı	1	ı	١	7	*	EDSE	NON-GLASSY SUGNEY GLASSY
NO-423-74-10	EP-423-66	200	09	210	5.0	01	2910	,	ARGON	2370	Ø	VACUUM	4.05	1	1	1	1	1	1	1	1	7	*	SURFACE, EDGE	VERLE-WOW
WO-423-74-7 WO-423-74-8 WO-423-74-9 WO-423-74-10 WO-423-74-11 WO-423-74-12	EP-423-66	200	65	091	5.0	Ø	2910	,	ARGON	2370	40	VACUUM	3.96	1		1	•	B	24	SURFACE, EDGE	NON-GLASSY		1	1	
NO-423-74-8	EP-423-66	200	60	165	5.5	9	2910	,	ARGON	2370	00	VACUUM	3.42			-		× 5	24	EDSE	NOW-GLASSY			1	1
NO-423-74-7	EP-423-66	200	55	165	5.5	0/	29/0	,	ARGON	2370	80	VACUUM	5.03	1			•	00	**	SURFACE, EUSE	NOW-GLASSY		ı		l
Specimen Number	Dispersion Number	Voltage	Milliamps	Time (Seconds)	Coating Thickness (mils)	S		Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	5 g	Transfer and Trans	Type of Faiture
-			cond					11.191		2	guizi	uooi	US	u	oits	oxic	Pre		Ŧ.(	0091	[		Ł	00₹	2

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: 23.6Mely-27.6GrSy-19.77.6g-19.1VSz

200	200 1-2	200	1-2-3-44 1-2-3-44 1-2-3-44 200 200 60 60 85	1-2-3-4A 200 105	1.2.3-4A 200 85	1-2-3-4A 1-2-3-4A 1-2-3-4A 200 200 200 205 85 85
125		125	300	135	360	360
6		9	0/	Q	01	9
27	2910	2910	2910	2010	29/0	29/0
~ 6	And the same of th	Joseph J	ARGON	ARGON	ARGON	ARGON
2   Rai	-	2370	2370	2370	2370	2370
00		00	00	8	8	00
	IUM	VACUUM	VACUUM	VACUUM	YACUUM	VACUUM
	2.56	3.17	2.80	0.02	0.68	3.02
, ,		1	1		•	
		4			1	
1 1		1	1	1	1	1
		1		1		1
-	7	12	//	1	•	5
	28	52	36	1		
	W	SURFACE, ECONE	SURFACE, EDGE	1	1	,
	72	NOW-GLASSY	NOW-GLASSY	•		1
	_			7		9
			1	+	N	*
1	1		1	EOSE	E0865	SURFACE
		-		GIGHTLY GLASSY	Alow-GLASSY	SIKHINY CHASSY

COATING: MoSiz-30CrSiz/VSiz

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	+		-	0 01 601 11	8 01. 501. 20	14/0-1172.110-11	2.67.5CT-97	W6-423-49-6
	(y)	Specimen Number	3	10-425-49-1	1.64.544.0W		-	(423-49-3)
		Dispersion Number	(423-49-3)	(4x5-44-5) 2-5C-1	2.50-1	2.50-1	2.50-1	2.50-1
	oit			(150)	(50)	(150)	150	150
••		Voltage	150	(34)	(30)	(35)	(30)	(35)
		Milliamos	9 5 5 2 5 5 5 2 5 5 5 5 5 5 5 5 5 5 5 5 5	55	55	55	55	55
			(120)	(120)	(02/)	(/20)	7000	180
	-	Time (Seconds)	180	08/	(20)	(01)	(0.7)	(0.1)
		Costing Thickness (mils)	50	200	3.0	0%	3.0	2:0
			(0)	(0)	(0)	9	96	<u> </u>
M	<u> </u>	Densification Press (tsi)	0/	0)	(000)	(0/0/0)	(0/62)	(2010)
	+-	To be the second of the second	(38/0)	0/0/0/	0/62	29/0	29/0	2910
	uir	1 emperature ( + )	(1)	(1)	(i)	37	<u> </u>	<b>}</b> ~
		Time (hours)	,	1	(1400000)	(140/04/)	(ARGON)	(ARGON)
		Atmosphere	(ARGON)	(ARGON) ARGON	ARGON	ARGON	ARGON	ARGON
305		(te)	0200	2370	2370	2370	2370	2370
		Temperature ('F')	43/0			0	0	d
		Time (hours)	00	00	Ø	Ø	0	١
	con	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	•	Trinos process	0 (7)	200	2.35	3.03	3.92	3.82
		Weight Gain (mgs/cm²)	7,57	/ 7.7				
		Temperature (°F)	1	1	1	1	1	
	atic	Time (minutes)	1		1	Carren	1	•
		(COMMITTEE OF THE PARTY OF THE		1	1	Ş	1	•
	·····	Atmosphere	1	1				
	ъ	Weight Gain (mgs/cm²)	l	1	1	1	5	
9		Number of Cycles	44	44	74	J		1
LL	Æ	Original Life (house)	2007	399+	252	1	•	•
esn	009	Oxidation Dire (nours)	Crut IMTRET	CTILL INTRCT	PATCH	1	1	1
ят	t	Type of Failure	Abal- G1ACCV	Mow-GIASSY	Now-GLASSY	١	)	ı
SII		S	Court and		4	2	77	1
LN		Number of Cycles				00	120	06
OI:	Ŧ.	Oxidation Life (hours)	-	}	•	2		
ΓΑG	00₺	Type of Failure	1	1	3	GENERAL	MATCH	rateh
пхс	z	A Programme of Cost	1			NOW-GLASSY	Nov-GLASSY	Now-GLASSY
		20						

COATING: MoSiz-30C.Siz /VSiz

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

103 6611 741	180-443234-01	(423-49-3) EP-423-57-1	(05/)	(20)	45/	(180)	120	9.6	(0)	0)	(2010)	29/0	27	(MEGON)	ARGON	2370	B	VACUUM	3.77	1	1	(			1		ı	ł	2/	8	Sularke	QUEHTZY GLASSY
Jus 601 71	WO-425-34-4 WO-425-34-3 NO-425-34-0	(423-49-3) EP-423-57-1	(150)	2000	(\$. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.	(180)	120	000	(0)	0	(20/62)	2010	37	(ARGOW)	ARGON	2370	Ø	VACUUM	2.15	1	1	(	1		1	1	,	1	35	244	CORNER	SURHILY GLASSY
1. 100 001. 1.	WO-425-34-4	(423-49-3) EP-423-57-1	(05/)	130	i s	(180)	120	(01)	770	9	(0/62)	2910	3	(ARGON)	ARGON	2370	B	VACUUM	2.22	1		1	1		1	1	-	1	0/	94	FATCH	SUGHTLY CHASSY
	WO-423-29-3	(423-49-3) EP-423-57-1	(05/)	150	(45)	(180)	120	(01)	2:0	39	(38/0)	2010	<u></u>	(ARGON)	ARGON	2370	Ф	YACUUM	3.70	,	,	1			21	406+	STILL INTRET	NON-GLASSY	J	1	1	ì
	WO-423-592	(423-49-3) Ep. 423-57-1	(051)	150	(40)	(087)	120	(01)	2.0	9	(29/0)	29/0	S-	(A GGOV)	ARGON	2370	Ф	VACUUM	2.18	1	,				35	442	CORNER	NON-GLASSY		,	1	1
	WO-423-591	(423-49.3)		150	(ot)	(180)	720	(01)	2.0	26	(20/0)	29/0	(i)	(ADSON)	ARGON	2370	00	VACUUM	3,57	1	1	)		1	31	+90+	STUL INTACT	Now-GLASSY		1	1	1
	Specimen Number	Dispersion Number		Voltage	Milliamne	o derection	Time (Seconds)	,	Coating Thickness (mils)	Densification Press (tsi)		Temperature (°F)	T. (1, 0, 1, 0)	rune (nours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	(F)	Time (minutes)		Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface		Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface
f		su	o£‡	ibı	10	) 8		-	<u> </u>		Д.		irə	-		<u> </u>	·: ·	icon		u	oits	oxio	916	I		· ·	1 200 		aT		00₹3	
L							S	ВВ	L	ME	ΑS	Ι¥	d :	SS:	CE	РВС	AG 1	ILT.	CO						. S.	ı 111	3.LC		لبدد			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSiz - 30Cr Siz / VSiz

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

WO-423-59-8 WO-423-59-9 WO-423-59-0

(423-49-3) (423-49-3) (423-49-3)

WO-423-57-1 WO-423-57-1 WO-423-57-1

(150) (150) (150) (150) (150)

(160) (160) (160) (150)

(10) (10) (10) (10)

(10) (10) (10) (10)

(2910) (2910) (2910)

(2910) (2910) (2910)

(1) (1) (1) VERY GLASSY VACUUM (ARGON) ARGON 2370 2910 15.6 DIE 3003 15/4 19 USWL GUNSON SURFACE VACUUM ARGON 2370 2.38 1866 2910 5 4.10 Ñ 1 0 SUGHRAY GLASSY CORNER (ARGON) ARGON VACUUM 2370 4.26 180 2910 AK N 4 00 Appearance of Coating Surface Appearance of Coating Surface Coating Thickness (mils) Densification Press (tsi) Weight Gain (mgs/cm2) Weight Gain (mgs/cm²) Oxidation Life (hours) Oxidation Life (hours) Dispersion Number Temperature (°F) Number of Cycles Specimen Number Temperature (°F) Number of Cycles Temperature (°F) Type of Failure Type of Failure Time (minutes) Time (Seconds) Time (hours) Time (hours) Atmosphere Atmosphere Atmosphere Milliamps Voltage Preoxidation 1200.E J.00⊅7 Sintering Conditions

COVIING PROCESS PARAMETERS

OXIDATION TEST RESULTS

COATING: Mosiz-2011sig /Vsiz

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REFER
PARENTHESIS
DATA IN

Specimen Number   Why 473-70-4   Wh 473-70-4   Wh 473-70-4   Wh 473-70-4   Wh 473-70-6   Wh 473-70	11 000 0011	WO-443-10-11	EP-423-64	18 6 6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	(32)	(2)	150	(0:1)	9	0	(29/6) 29/0	ė	(ARGOW)	ARGON	2370	100	VACUUM		2.54	•	1			)	•		1	1		36	700	STILL INTRE	+-	アーとはいうなどと
Specimen Number   No.	VO-423-70-V	EP-423-64	(100)	(38)	200	720	(0.0)	200	9	(29/0)	in	(ADCON)	ARGON	2370	91	JAPILLIA	2000	3.30	1	ı		1	1	1	1	1	1		92	289	_	+	Alast-12/255	
Specimen Number   Work3-70-2 Work3-70-4 Work3-70-4 Work3-70-4 Work3-6-1		WO-423-70-8	(EP-423-64) EP-423-64	(001)	(38)	75		(01)	1. S	9	(2010)		1405,041	ARGON	2370	9/	Comme	VACUUM	14.41	1	1		1			1	1	1		56	ook	CHINI INLINC		Mast. 1910CC
Specimen Number (F) (A) (A) (A) (A) (A) (A) (A) (A) (A) (A		WO-423-70-6	(EP-423-61) EP-423-64	(100)	(32)	8	38	(0/)	3.4	35	(29/0)	2000	/	ARGON	2370	1/4		VACUUM	3.39	1	1		***************************************	1	25	SON	Crui MIBCT	21111 1111	NOW-CLASSY	1	1			
Specimen Number  Onditions  Dispersion Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Siliconist (*F)  Time (hours)  Atmosphere  Siliconist (and (mgs/cm²)  Weight Gain (mgs/cm²)  Number of Cycles		NO-423-704	(EP-423-61)	(00/)	200	45	(2/)	801	5.0	99	(2%2)	29/0	,	(ARGON) ADGON	2470	77	9/	VACUUM	3.25	. 1			1	1	28	80%	300	FOOE	NOW-CLASSY	1	1			
Specimen Number  Onditions  Dispersion Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Siliconist (*F)  Time (hours)  Atmosphere  Siliconist (and (mgs/cm²)  Weight Gain (mgs/cm²)  Number of Cycles	2	10-423-70-2	(EP-423-41)	(00)	28	100	(11)	75	4.3	(ō):	(29,0)	29/0	:~	(Masow)	0220	2104	9/	VACUUM	4.22	1		1	1	ļ	/0/	1360	1000	STILL INIACI	NOW-GLASSY				•	
400°F 1500°F Preoxidation Siliconizing Sintering Plating Conditions	A IN PAKENINECE COL			Todaya Maria	Voltage	Milliamps		Time (Seconds)	۳			Temperature (°F)	Time (hours)	Atmosphere	1		Time (hours)	Atmosphere	Weight Gain (mgs/cm²)		Temperature ( F)	Time (minutes)	Atmosphere	Weight Gain (mas/cm²)	Weight dam (mgs.)			Type of Failure			Number of cycles	Oxidation Life (hour	Type of Failure	
OPTION TEST RESULTS CONTING PROCESS PARAMETERS	DAL							nite	ы			gui	191	uis		Bur					1011	ida	ixoe	ьта	+									

COATING: MoSiz - 2017.512 / WSiz

DATA IN PARENTHESIS REFER TO VSI2

WO-423-72-12 Now-GLASSY CORNER (ARGON) ARGON MOUNT 258 2.43 2370 77 10 (FP 423-61) (100) (10 WO-423-72-11 STILL INTRCT VACUUM ARGON) 3.34 446 2370 3 1 1 ١ ı ı ١ 10 WO-423-72-15 WO-423-72-5 EP 423-63 (100) (1 YACUUM (ARGON) ARGON HATEH (EP-423-61. 2370 824 00/ 200% ) ١ ١ ı 1 l 6 1 NON-GLASSY (EP 423-61)
EP 423-64
(100)
200
(100)
37
(100)
45
45
(3.0)
3,0
(0)
(0) VACUUM 3.20 2370 (ARGON, 14/ EDGE 9 1 > 1 1 NOW-GLASSY STILL INTRCT WO-423-72-13 WO-423-72-14 (FP-423-41) (EP-423-61) (EP-423-61)
(D00)
2370 VACUUM (ARGON) ARGON 446 ١ 9 Ì 6 1 ١ ì ŧ 1 NON-GLASSY (EP-423-64)
(180)
(180)
(180)
(200
(57)
(42)
(180)
(190)
(2)
(2)
(2)
(2)
(2)
(3) STILL INTACT VACUUM (ARGON) ARGON 8681 2370 4.14 88/ i 1 ı ١ ı Ø Appearance of Coating Surface Coating Thickness (mils) Densification Press (tsi) Weight Gain (mgs/cm²) Weight Gain (mgs/cm²) Oxidation Life (hours) Oxidation Life (hours) Dispersion Number Temperature (°F) Number of Cycles Number of Cycles Temperature (°F) Temperature (°F) Specimen Number Type of Failure Type of Failure Time (minutes) Time (Seconds) Time (hours) Time (hours) Atmosphere Atmosphere Atmosphere Milliamps Voltage 1 200 E 5400.E Preoxidation Sintering Conditions

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NON-GLASSY

NON-GLASY

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Appearance of Coating Surface

OXIDATION TEST RESULTS

COVIING PROCESS PARAMETERS

COATING: MoSiz-40lisis /1052

COATING: Mosiz - 40c-Siz /45iz

DATA IN PARENTHESIS REFER TO VSi

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WO-423-79-	(EP-423-62)	EP-423-65	175	(41)	100	(98) 1000 1000 1000 1000 1000 1000 1000 10	(3:0)	2.5	<i>39</i>	(0162)	0/6%	<u>``</u>	ARGON	2370	Ø	Meuum	1.43	J	1	,	,	ı		1		56	406	STILL INTACT	NON-GLASSY
1410-492.72.14 WO-423-79-16	(EP-423-62)	EP-423-65	(20)	(15)	95	(06)	(2.9)	2.5	96	(2010)	20/62	), ,	(ARGON) ARGON	2370	8	VACUUM	1.14	e constru	1	1	ı	ı	1	ı	)	36	310	EDGE	Nav-GLASSY
W 472.70.19 Wh. 472.98.12	(EP.423-62)	EP-423-65	(001)	(05)	95	(06)	(3.0)	3.0	99	(20/67)	2910	<i>'</i> '	(ARGON) ARGON	2370	Ø	VACUUM	0.77	•	1	1	1	1	(			56	406	STILL INTRET	NON-GLASSY
1410 492.70.19	(EP-423-62)	EP-423-65	(001)	(77)	95	(06)	(3.0)	3.0	99	(0/62)	2910	<b>\$</b> ~	(ARGON) ARGON	2370	80	VACUUM	0.53	1	ı	ı	1	60	414	STILL INTRET	NON-GLASSY	-	ł	•	<b>J</b>
11 00 001 71	WU-TK2-10-11	EP.423-65	(00/)	(2)	/00/	(06)	135	3.0	ĝ <b>§</b>	(29/0)	2910	€~	(ARGON) ARGON	2370	00	VACUUM	49.0	1		J	•	36	310	CARNER	Now-CRASSY	•	-	ı	-
000 000	WO-425-18-7	EP-423-65	(00/)	175	95	(01)	(2.4)	3,0	ê Ş	(0/67)	2910	€~	(ARGON) ARGON	2370	00	VACUUM	0.60		1	1	1	36	310	FOGE	NON-GLASSY	,	1		1
Specimen Number		Dispersion Number	17-14-14-1	v ortage	Milliamps .		Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	1	Temperature ('F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation I	Type of Failure	
		suo	ŢŢŢ	pu	၀၁	Bu	its.	Гd		1	3u j	191	uīS	81	nizin	iooi.	ŢS	uc	dati	ixoə	1d			1 20				0017	
							SHI	LE	ME	AЯ	٧c	ı s	CES	ояа	NC 1	ITA	ဝ၁					S.	מרז	въз	TS	LL	/OI	[DA]	IXO

COATING: MOSiz-2011Siz fo.5VSiz

																								(A)							
WO-423-84-24	(3-13)	2-4A	(00/)	(32)	15.	(20)	150	(0.1)	4.0	<u>6</u>	(0/62)	2910	<b>*</b>	(ARGON) ARGON	2370	0	VACUUM	604			1	1	1		28	SURFACE	Now-GLASSY	3	ı	1	,
WO-423-84-23	(38)	2.44	(00)	(32)	165	(20)	150	(0.1)	4.0	9	(0/62)	2910	<u></u> }\	(ARGON) ARGON	2370	Ø	VACUUM	1.57		1	4	(	1	77	52	CORNER	NON-GLASSY		,	1	1.
Wo-423-84-18	(38)	2-4/A	(001)	00/	33	(20)	120	(0:1)	4.2	<u>6</u> 9	(29/0)	2910	3>	(ARGON) ARGON	2370	8	VACUUM	1.05		•		1	1	8	28	EASE	NON-CALASSY		1	1	1
WO-423-84-1 WO-423-84-8 WO-423-84-18 WO-423-84-23 WO-423-84-24	(38)	7-4/4	(001)	200	(35)	35	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	(0/)	4.0	<u>6</u> 8	(20/0)	29/0	€~	(ARGON) ARGON	2370	0	VACUUM	720		1	1			7	28	CORNER	NON-GLASSY			1	1
W6-423-84-1	(38)	2-4/4	(001)	200	(0/+)	105	9 5	(40)	\$.*X	(0)	(30/0)	2910	3	(ARGON)	2370	00	VACIUM	777	1:07	ı	•	1	1	96	929	STILL INTACT	Nan-(2LASSY	1	1	1	)
Specimen Number		Dispersion Number		Voltage		Milliamps	Time (Seconds)	Time (seconds)	Coating Thickness (mils)	Donoification Press (tsi)		Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	minospinos (	Weight Gain (mgs/cm-)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Annearance of Coating Surface	89	Oxidation Life (		
Ē	_	_	tic	ipi	uo	<u> </u>			Id					iniS		1G F				uο	itsb	ixoə	Τđ			00S I		TES		007	

COATING: MoSiz-2017.52,

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

Specimen Number																												
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	140-423-841-31	(3-6)	(00/)	(410)	000	153	(7.0)	200	(0/62)	0/67	?^	(ARGON) ARGON	2370	0	VACUUM	1.65	4	1	1	1	7	28	CORNER	NON-GLASSY	ı	1	1	1
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	WO-423-84-30	V/~Z	(001)	(35)	200	155	(7.0)	(0)	(2010)	2910	() ()	ARGON	2370	8	VACUUM	1.31	1	ı	1	}	17	124	SURFACE	Now-GLASSY	1		1	
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	02-48-874-9V	(8-8) Ar-6	(001)	(35)	45	153	(0.1)	(6)	(0/62)	29/0	§~	(ARGON) ARGON	2370	00	VACUUM	1.52	1	1	ı	ı	17	124	COIZMER, EDGE	NON-GLASSY	•	1	1	1
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mils)  Densification Press (tsi)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating Surface  Number of Cycles  Oxidation Life (hours)  Type of Failure	10-423-64-28	(3-8)	(00/)	(35)	45	155	(01)	000	(29.0)	20/0	3∼	(ARGON) ARGON	2370	80	VACUUM	1.73	1	1	1	,	^	28	EDSE	NON-GLASSY	1	ı		1
Specimen Number  Voltage  Milliamps  Time (Seconds)  Coating Thickness (mil Densification Press (ts Temperature (°F)  Time (hours)  Atmosphere  Temperature (°F)  Time (hours)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Time (minutes)  Time (minutes)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Time (minutes)  Atmosphere  Weight Gain (mgs/cm²)  Number of Cycles  Oxidation Life (hours)  Type of Failure  Appearance of Coating  Number of Failure	MO-473-84-25	(3-8)	(001)	(35)	45	(20)	(7.0)	(0)	(29/0)	2910	3-	(ARGONI) ARGON	2370	00	VACUUM	0.86	3		ı		2	28	SURFACE	NOW-GLASSY	1	ı		
			(7)	Voltage	Milliamps	Time (Seconds)	0 0	(in)		Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	(mgs		Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles		Type of Failure	Coating	Number of Cycles		Type of Failure	Appearance of Coating Surface
OXIDATION TEST RESULTS COATING PROCESS PARAMETERS		su	oiti	puo	၁					_							uc	dati	ixos	υzα	s				LE			

DATA IN PARENTHESIS REFER TO VSi,

COATING: MOS12-2017S12/05 VS12

10-423.84-2	(3-B)	(100)	001	33 45 45 45	(20)	(0,0)	4.3	99	2910	<b>3</b> ~	(ARGON) ARGON	2370	8	Menum	1.16				.1	1			1	7	28	EOGE	Now-GLASSY
NO-413-84-26 NO-423-84-29	(3-8)	(100)	001	(35)	(0%)	(20)	4.7	<i>60</i> /	(2910) 2910	<u> </u>	(ARGON) ARGON	2370	0	VACUUM	0.86		1	ı	1		•		1	K	28	CORNER	Now-GIASSY
346.5	(3-8)	(001)	200	(o) (0)	(20)	700	4.4	<i>60</i>	(2910)	\$\	(ARGON) ARGON	2370	Ø	VACUUM	46.0	ı	1	1	1	1	1	1		0	32	CORNER	ASSOLA-Luda
WO-423-84-3	(3-8)	(001)	200	(0/2)	(20)	150	4.5	<u> </u>	(29/0)	(0)	(ARGON) ARGON	2370	8	VACUUM	1.06	1	1	1	١	1	1			2	28	EDGE	. har Lances
4-2	(3-8)	(190)	200	(40)	(20)	(20)	(6.7r	<u>6</u>	(29/0)	\$-	(ARGON) ARGON	2570	00	VACUUM	1+1	1	1	1	1	1	1		1	82	534	PATCH	Course Place
Specimen Number	Digneration Number		Voltage	Milliamps		Time (Seconds)	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
SF					gu	_		ΙĞ	_	ireri   H			iizin E			+	idati		<del></del>	Z	O.E.		_4	Z		∑₹00	_

COATING: MoSiz -207.512

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

Wo-423-84-37	2-48	(001)	(oh)	09	(20)	(1:0) 4:4	9	(2010)	29/0	<u></u> ~	(HRGON) ARGON	2370	8	VACUUM	1.55		1	1	1	,	J	1	1	12	23	CORNER	NOW-GLASSY
	(3-B) 2-4A	(001)	(0/1)	90	(20)	(0:1) ***	(0)	(28/0)	2910	€~	(ARGON) ARGON	2370	00	VACUUNI	19:0	1		1	ı	•	-	1	J	7	28	EOSE	Now-GLASSY
Wo-423-84-35	(3-8) (3-8) (3-8) (3-8) 2-44 2-44 2-44	(00/)	(40)	90	(20)	(1:0)	9	(2/62)	29/0	\$~	(ARGON) ARGON	2370	8	VACUUM	0.65	1	ſ	1	١	1	1	4	•	7	28	3903	NON-GLASSY
WO-423-84-34	(3-B) 2-4A	(001)	(40)	. 60	(20)	(7:0)	(0)	(2910)	2910	(i)	(ARGON) ARGON	2370	Ø	VACUUM	0.76	1	1	1	-	1	1	J	1	7	28	CORNER	Now-GLASSY
WO-423-84-33	(3-8) 2-4A	(00/)	(070)	9	(20)	(01)	60	(29/0)	2910	<b>⊕</b>	(ARGON) ARGON	2370	00	УАСИЛИ	1.15	,	1	ļ	1	1	1	1	1	6	32	CORNER, SURGING	NON-GLASSY
Specimen Number	Dispersion Number	Voltage	v ortraß c	Milliamps	Time (Seconds)	Coating Thickness (mils)			Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface
	suc	_			gui	Ызғ				teri	niS	_	izin	licoi	is	uo	itabi	хоэ.	Ιđ		4.0	09 T			.E	00₹2	
					S	нэл	ME	A.S.	ΙV	a s	CES	ьвс	ИĊ	ITA	ဝ၁					S	רעט	SER	TS	'TE	LIOI	ναι	хо

COATING: MOSiz-20TiSiz

100 00 00	WO-445-50-50	(3-0) 2-4C	(00)	(20)	70	(20)	200	3.0	<i>§</i> 9	(29/0)	3	(ARGON)	ARGON	2370	8	VACUUM	0.61	2910	~	AIR		8	*	GENERAL	Nov-GLASSY	1	•	1	,
9 00 00	NO-725-88-27	(3-B) 2-4C	(001)	200	204	(20)	040	3.0	99	(29/0)	(i)	(ARGON)	ARGON	2370	8	VACUUM	0.78	2910	ø	AIR	ı	N	*	GENERAL	Non-GLASY	1	ı	1	•
	WO-427-88-20 WO-425-88-27 WO-425-80-50	(3-6) 2-4c	(001)	200	107	(20)	04	0 6 m	<u>(0)</u>	(26/6)		(406014)	ARGON	2370	Ø	VACUUM	1.15	0/62	e/	AIR	1	N	7	GENERAL	NON-GLASSY	ł	1	1	1
-	Ø16	(3-8)	(100)	200	(dt)	(20)	07	9 0 6 0	99	(29/0)	(1)	110600	ARGON	2370	80	VACUUM	0.09	2910	W	AIR	1	2	*	GENERAL	NOW-GLASSY	-	1		•
TO VSi2	WO-423-08-15	(8-8)	(001)	200	640	(20)	<i>\$</i>	6.0	9	(20/67)	2010	1	ARGON	2370	00	VACUUM	3.5-9	0166	W	AIR	1	8	*	CTEIVERAL	NON-GLASSY	1	1	-	)
DATA IN PARENTHESIS REFER	Specimen Number	Dispersion Number		Voltage	Williamps	<b>1</b>	Time (Seconds)	Coating Thickness (mils)	1 4	. 1	remperature ( + )	Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	Atmosphere	Weight Gain (mgs/cm²)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)		Appearance of Coating Surface
-				-	100	8		PIa		L_		əşu		L	nizio			u	latio	ixoə				1200				00 <del>1</del> 7	
							S	LE	MEJ	AA.	Αđ	SS	CE	ORS	NC 1	ITA	ဝ၁	•				S	ULT	SES.	LIS	<u>АТ</u> 1	AOI.	ΓAG	IXO

COATING: Mosiz-2011.5:2,

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

WO-423-88-14	(3-8)	2-40	(00/)	ZOO	64	24	679	370	50	200	2	(2010)	2910	(3)		(ARGON)	AKGON	2370	Q	) )	VACUUM	98.0	0,00	4410	W	AIR		N	*	(LEUE PAC	Concin	Now-GLASSY	•	4	1	
0/-	(3-8)	2-40	(100)	200	(40)	040	(07)	40	(6.6)	2.0	3	(2010)	20/0	(3)		(ARGON)	AKGON	2370	a	0	VACUUM	0.62	200	XXIO	W	AIR		N	*	Couron	CENERAL	NOW GLASSY	1	1	ı	
WO-423-88-9 WO-423-88	(3.8)	2-40	(001)	200	(0%)	40	(20)	40	9.6	3,0	્રેક	(000)	2010	(1)		(ARGON)	ARGON	2370	9	0	VACUUM	0.51		2910	W	AIR	1:	7	h	Common	CJENEKAL	Now-GLASSY	1	1	1	1
		2-40	(001)	200	(0/1)	40	(20)	40	(0'1)	3.0	9 <	(20,0)	1000	(1)	. ~	(ARGON)	ARGON	2370	(	ď	VACUUM	0.55		2910	W	AIR	3	N	*		GENERAL	NOW-GLASSY	1	1		1
W6-423-88-5 W6-423-88-7	(3-8)	2-40	(00/)	200	(ofr)	30	(20)	45	(0.1)	3.0	<u></u>	(0)	2000	43/10	<u> </u>	(ARGON)	ARGON	2370	1	a	VACUUM	0.58		2910	W	AIR	1	7	A		GENERAL	MON-GLASSY	)	1		1
Specimen Number		Dispersion Number		Voltage		Milliamps		Time (Seconds)	1 '	Coating Thickness (mils)	(i) C	Densilication riess (1917)	Temperature (°F)		Time (hours)	/	Atmosphere	Temperature (°F)		Time (hours)	Atmosphere	Weight Gain (mas/cm²)	11	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Original life (house)	4	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	E. D. C.	Announce of Costing Surface
		_		_	<del></del>	-	8		ŢSĮ						rei	uţ	S	8	luț	zţu	ico	Ţ!S		uo	itsb	ixo	Pre		_	009	,				00Đ	
	COPTING PROCESS PARAMETERS												s	OXIDATION TEST RESULTS																						

COATING: MoSiz - 2017.52

DATA IN PARENTHESIS REFER TO VSi<sub>2</sub>

WO-423-88-11 WO-423-88-12 LUGATZY GURSY CORNER ARGON VACUUM 2910 (3.6) 2370 N/V 0.57 X N η 1 1 1 Ø 1 KINGHIZY GLASSY Moun 2370 (ARGON) ARGON 0.54 2910 タイプ (1.00) (2 FOGE X 158 M ı 1 W 423-88-8 SUGATEY GLASSY SURFACE VACUUM (ARGON) ARGON 2370 0.54 2910 AIR 29/0 158 Ø 1 W ١ NON-GLASSY 1NO-423-88-2 VACUUM (ARGON) ARGON CORNERS 2370 0.77 (200) 0162 AIR SURFACE, PATCA WO-423-88-1 NON-GLASSY (ARGON) ARGON VACUUM 2370 0.56 2910 AIR ١ 00 ١ W Surface Appearance of Coating Surface (mils) (tsi) Weight Gain (mgs/cm²) Weight Gain (mgs/cm²) Appearance of Coating Oxidation Life (hours) Oxidation Life (hours) Densification Press Dispersion Number Coating Thickness Specimen Number Temperature (°F) Temperature (\*F) Number of Cycles Temperature (\*F) Number of Cycles Type of Failure Time (minutes) Type of Failure Time (Seconds) Time (hours) Time (hours) Atmosphere Atmosphere Atmosphere Milliamps Voltage Preoxidation 1200.E Z400.E Conditions OXIDATION TEST RESULTS COATING PROCESS PARAMETERS

COATING: MoSiz-2015/12/Siz

DATA IN PARENTHESIS REFER TO VSi2

																		1														
Wo-423-88-22	(3-3)	2-40	2007	(770)	40	(02)	200	3.0	(o)	(2/02/	2010	CØ.		ARGON	2370	Ø	VACUUMI	0.56	2,00	72/10	~	AIR		J	f			27	158	COSE	EVOE.	Now-GLASSY
28-88-87-00 01-88-29-10 18-88-82	(4-4)	2-40	0000	600	707	(20)	200	0 (S	(ō)	07	20/0/	3		ARGON	2370	00	VACUUM	0.87	2,00	77/7	Ŋ	AIR			1	1	1	25	0/1	0,500		SIGNILY GLASSY
110-473-89-19	WW-14/0010	2-40	(00/)	707	0 P	(20)	Q.;	(%) (%)	(0)	0	70/07	3	,	(ARGON) ARGON	2370	Ø	VACUUM	0.35	******	7.210	M	AIR		)	1	1	1	W	9	20,000	CORNER	GIGHTT GLASSY
11 88-111-98	11-02/74-0A	2-40	(001)	200	(0%)	(20)	or or	6.6 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0	9	Q	(2000)	200	/	(ARGON) ARGON	2370	00	VACUUM	0.68		29/0	M	AIR		1	1			975	200	1000	STILL INTACI	SUGHTLY CLASSY
0000	0.12	07-70 7-70 7-70 7-70	(100)	200	£ \$ \$	(20)	20%	(5.6)	60	0)	(28/0)	2000		(ARSON) ARGON	2370	ø	Spelling	1.25	600	2910	*	AIR		1			1	17	67	94	EDGE	NOW-GLASSY
Shearings Number		Dispersion Number		Voltage	Milliamos	T.	Time (Seconds)	Coating Thickness (mils)		Densification Press (tsr)	Temperature (°F)		Time (hours)	Atmosphere	Temperature (°F)	Time (hours)	4 tmoonhore	Weight Goin (mas lom2)		Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	1	Appearance of Coating Surface	00000	Carried of Cycles	Oxidation Life (nours)	Type of Failure	Appearance of Coating Surface
		su			100	81		Pla		TAT T	L_			sa. ais		nisi				uoi	tab	ixoe	Pr.	9		0051 1531		тЕ		.00 		
	COPTING PROCESS PARAMETERS													OXIDATION TEST RESULTS																		

COATING: MoSiz - 40CrSiz /1.5 VSiz

data in parenthesis refer to  ${
m vsi}_2$ 

	4	DAIA IN FANCINESS	7					
		Specimen Number	Wo-423-86-6	WO-423-86-12	WO-423-86-12 WO-423-86-15 WO-423-86-17 WO-423-86-18	Wo-423-86-17	Wo-423-86-18	
	su	Dispersion Number	(3-8)	(3-8)	(3-8)	(5.6) (5.6)	50 de (2)	
	oii		(00/)	(001)	(100)	(001)	(100)	
	ib	Voltage	150	150	1.50	150	150	
	uo O	Milliamos	(04)	(\$ \f	300	£55	(\$) (\$)	
	gu Bu		(06)	(06)	(06)	(06)	(%)	
виз.	iteľ	Time (Seconds)	(3.0)	(3.0)	(3.0)	(5.0)	(3.0)	
MEL	<b>T</b>	Densification Pres	(0)	(0)	(0)	(0)	(0)	
AAA	Bt	Temperature (°F)	(29/0)	(2910)	(29/0)	(29/0)	(29/0)	
√a s	rerin	Time (hours)	(1)	(3)			(0)	
CES	niS		(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	
ояа	ਰਿ	Temperature (°F)	2370	2370	2370	2370	2370	
4C 1	nizi	Time (hours)	00	00	Ø	B	O	
IIΤΑ	icon		VACUUM	Mevum	MACUUM	VACUUM	Macuum	THE STATE OF THE S
က	ŢŢS		0.20	84.0	0.39	0.39	14.0	
	uc			1	1	•	•	
	dati	Time (minutes)		•		1	1	
	ixoa	Atmosphere	.1		1	•	1	
	Pr		ı	1	1	•	1	
S	-	Number of Cycles		1	•		ı	
LJU	J.O	Oxidation Life (hours)			1	1	ı	
EES	091	Type of Failure			ı			
TS		Appearance of Coating Surface	1	1	1	1	,	
1 L		Number of Cycles	16	16	16	16	77	
IOI	- I.		626	626	626	626	52	
ΙΦΨ	0077	Type of Failure	STILL INTACT	STILL INTACT	STUL INTROL	STILL INTACT	CORNER	
OX	:	Appearance of Coating	Surface SIGHTLY GLASSY	SLIGHTLY GUISSY	SLIGHTLY GLASSY	NON-GLASSY	NON-GLASSY	
	$\frac{1}{1}$	1					ļ	

### COATING: MoSiz - 40CrSiz /1.5 VSiz PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

DATA IN PARENTHESIS REFER TO VSi,

0.70	+																											
(3-B)	2-5-6	150	(45)	50	45/	(3.0)	9	(2010)	2910	3-	(ARSON) ARGON	2370	8	VACUUM	0.33	,		1	1	1	82	532	EDGE	NOW-GLASSY		1	1	1
(3-8) (3-8)	2-50	(20)	(04)	45	(90)	(3.0)	(0)	(20,0)	29/0	<u>;</u>	(ARGON) ARGON	2370	Ø	VACUUM	0.45		ı	1	1	ı	16	979	STILL INTHET	Naw-GLASSY	1	1	1	}
WO-473-86-3	2-50	(200)	(04)	30	600	(3.0)	(0)	0/0/	29/0	<b>S</b> ~	(ARGON) ARGON	2370	00	MACUUM	0.33		1		-	1	16	626	STILL INTACT	NON-GLASSY	1	1	1	1
Wo-423-86-3	2.50	(00)	(40)	30	(06)	(3.2)	5.0 (0)	0/	29/0)	3,	(ARGON) ARGON	2370	00	VACUUM	0.20		,	1	(	1	16	929	STILL INTHICT	NON-GLASSY	1	ı	•	1
3.	2.50	(001)	130	200	(06)	(3.0)	0,0	0	(29/0)	(1)	(ARGON)	2370	00	Shemma	035	3	1	1		•	16	626	STILL INTACT	NON-GLASSY		1	1	1
	Dispersion Number		у отгаве	Milliamps	1-9	-1	Coating Thickness (mils)	Densification Press (tsi)	Temperature (°F)	Time (hours)	Atmosphere	Temperature (°F)		A tendence of the control of the con	Atmosphere	Weight Gain (mgs/cm.)	Temperature (°F)	Time (minutes)	Atmosphere	Weight Gain (mgs/cm²)	Number of Cycles	Oxidation Life (hours)	Type of Failure	Appearance of Coating Surface	Number of Cycles	Oxidation Life (hours)	Type of Failure	
		1	_	-	Bu	itsti	ď		Вu	(T.F	Sint	Я	luizi	con				iseb	ixoə	ъч	0	OLT	00S T		ज.T.		ΓΑα 00 <del>1</del> 3	

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